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Predictor Variables for Success in College Wrestling

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Predictor Variables for Success in College Wrestling

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Table of Contents

Contents Page

List of Tables

List of Figures

Abstract

Research involving a wrestler's success in competition is limited. Understanding the physiological attributes that a successful wrestler must exhibit will help coaches and wrestlers develop effective and efficient philosophies and training programs. The purpose of this study was to examine if there are attributes of male NCAA Division II collegiate wrestlers that can predict success in the form of competitive wins during the season. Participants were tested on five physiological attributes: percent weight change (preseason to in-season), anaerobic work capacity, shot velocity, lower body power, and handgrip strength. A multiple regression statistic generated a correlation matrix for the independent variables and dependent variable. The results showed only one independent variable (percent change in weight) correlated significantly ($F = 9.402$ and $p = .037$) with the dependent variable (percent wins). Additionally, 70.2% of the influence in changed body mass predicted success in wrestling ($r = 0.838$, $r^2 = 0.702$). These relationships imply that wrestlers who gained mass were more likely to win compared to those who did not. The researcher concluded that future research should test a larger and broader population of wrestlers, examining percent body fat and hydration levels, in addition to body mass measurements, as well as consider testing wrestlers throughout the season. Knowledge of the neurological and physiological strengths of successful wrestlers at all weight classes could better help coaches and trainers enhance physiological attributes and skills.

CHAPTER ONE: Introduction

Wrestling is one of the most challenging sports in the world. It is a combative sport that is defined by effort and determined by mental and emotional discipline (Letafatkar & Mohammad, 2012). In the United States, collegiate (also known as Folkstyle) wrestling is practiced by youth, high-school, and college wrestlers. The sport of wrestling is unique in that it has three scoring positions; offense, defense, and neutral (Henning, 2016). College wrestling consists of three rounds that total seven minutes (plus overtime if necessary) and points are awarded to the wrestler that can control or advance position against his/her opponent. In those seven minutes a wrestler must exhibit balance, muscular endurance, flexibility, power, speed, strength, and mental smartness (Letafatkar et al., 2012; Callan et al., 2000). Throughout the world, Freestyle and Greco-Roman wrestling are practiced as an Olympic sport.

Significance of the study

In Freestyle and Greco-Roman wrestling, points are given to an athlete when an athlete exposes their opponent's back to the mat. However, Greco-Roman wrestling consists only of upper body manipulation in which opponents are not allowed to attack below the waist. Collegiate wrestling is similar to Freestyle wrestling in that leg attacks are allowed. Studies have identified the physiological profiles of collegiate and freestyle wrestlers to consist of high aerobic capacities, upper and lower body strength, anaerobic power, isokinetic strength, flexibility, strength endurance of the trunk and upper extremities, high vertical jump, high mean and peak power, and low body fat percentage (Yoon, 2002; Baić, Sertić, & Starosta, 2007; García-Pallarés, López-Gullón, Muriel, Díaz, & Izquierdo, 2011; Bahman, Ioannis, & Navid, 2011). However, these distinct qualities are wide-range and do not determine if one attribute is more important than another or if one is more likely to contribute to wins in competition. Based on the aforementioned physiological profiles, four important variables were identified: percent weight change (preseason to in-season), upper body anaerobic work capacity, lower body power, and handgrip strength, along with with one skill: shot velocity, which to date has not been tested in research.

In 2011, García-Pallarés et al. found sprint speed to be an attribute of wrestlers. In addition, Zi-Hong, et al. (2013) found Chinese female wrestler's 400 m sprint speed was significantly correlated with maximal peak power (r = 10.804, p = 0.016, watts per kilogram). Whereas, Bahman et al. (2010) concluded that a four-time World Greco-Roman wrestling champion's 40 m sprint was faster than the national norm (4.57 s versus 5.15 s) which was one of the physiological abilities that contributed to his wrestling success. Thus, included in this study was a speed test in the form of shot velocity. Shot velocity was selected because it directly relates to the sport of wrestling. Additionally, the current study is unique because to date no existing studies have been identified that assess shot velocity on wrestlers.

Purpose

The purpose of the researcher's study was to determine if the following five attributes: percent weight change (preseason to in-season), upper body anaerobic work capacity (arm cycling), shot velocity, lower body power (vertical jump), and handgrip strength of male Division II collegiate wrestlers, can produce a significant predictor equation for percent wins in competition.

Hypothesis

The researcher hypothesized five separate hypotheses:

1. Percent weight change (preseason to in-season) would be a significant predictor of percentage of wrestling matches won in a collegiate season.

2. A 30-second maximal arm cracking would be a significant predictor of percentage of wrestling matches won in a collegiate season.
3. Shot velocity would be a significant predictor of percentage of wrestling matches won in a collegiate season.
4. Vertical jump height would be a significant predictor of percentage of wrestling matches won in a collegiate season.
5. Handgrip strength of the non-dominant hand would be a significant predictor of percentage of wrestling matches won in a collegiate season.

Limitations and Delimitations

Limitations of this study included:

- Low number of subjects/participants.
- Variance in number of wrestling matches competed.
- Wrestlers talent level.

Delimitations of this study were:

- Subjects consisted of males between 18-25 years of age.
- Division II wrestlers from the University of Central Oklahoma.
- Having competed in the 2015-2016 wrestling season.
- No adjustments were made on the resistance of the cycling arm crank.
- Measuring body fat percentage should have been considered as opposed to percent weight change.

CHAPTER TWO: Review of Literature

The physiological attributes of wrestlers examined in previous studies included: anthropometric characteristics, aerobic and anaerobic capacity, strength, speed, flexibility and power (Bahman et al., 2011). The purpose of this literature review was to evaluate the physiological attributes of successful wrestlers. Five attributes of a wrestler were discussed: percent weight change (preseason to in-season), anaerobic work capacity, shot velocity, lower body power, and handgrip strength. These attributes were important because previous studies (Yoon, 2002; Baić, Sertić, & Starosta, 2007; García-Pallarés, et al., 2011; Bahman et al., 2011) have shown these physical attributes to be those of successful wrestlers. To date, no research has been conducted to determine if one of these attributes best predicts success in competition. Examining these studies and understanding what has been found provided a clear direction and need for the current research study. This literature review examined numerous studies and findings related to physiological profiles of wrestlers and attributes for wrestling success. As the review comes to a conclusion, the researcher's own study provided insight for new information and future studies. The purpose of this study is to determine if the aforementioned five attributes of a male, Division II collegiate wrestler can produce a significant predictor equation for percent wins in competition.

Athlete Physiological Profile

Every athlete has their own physiological characteristics that contribute to their individual success. When compared to other sports, wrestlers have a broad variety of physiological characteristics that lead to their success. Bahman et al. (2011) published a case study comparing anthropometric and physical traits of an Iranian four-time (2005-2009) World Greco-Roman wrestling champion to the national norms. The authors compared anthropometric measurements, muscular endurance, strength, aerobic capacity, flexibility, reaction time, agility, and speed to the national norms in the 55 kg weight class for Greco-Roman wrestling. Results showed the subject to be taller and have a greater wingspan than the national norm. His pull-up, sit-up, squat, speed, and agility test results were higher than the national norm. The result of his visual reaction time test was better, but his trunk-and-neck extension, shoulder-and-wrist evaluation, and bench press test results were lower than the national norms. Overall the subject tested better than the national norms in the same 55 kg weight class. Despite the isolated findings of this case study, successful wrestlers, regardless of weight class, have generally been found to have similar anthropometric measurements, muscular endurance, lower and upper body power, strength, aerobic capacity, flexibility, quick reaction time, agility, speed, and strong handgrip (García- Pallarés, Izquierdo, López-Gullón, & Torres-Bonete, 2012; García-Pallarés et al., 2011; Bahman et al., 2001).

Percent Weight Change

Wrestlers involved in collegiate wrestling compete in one of 10 predetermined weight classes. They are required to make weight before each match; for this reason, it is important for them to maintain an optimal body composition. Previous studies have shown elite collegiate wrestlers significantly reduce weight before a match and gain weight following competition (Ransone & Hughes, 2001). Oppliger, Case, Horswill, Landry, and Shelter (1996) found college wrestlers to average a weekly rapid weight loss of 4-5 pounds and may even exceed 6-7 pounds with an in-season body fat percentage of 6-7%. In 1998, the National Collegiate Athletic Association (NCAA) implemented a program to prevent wrestlers from competing below a minimum of 5% body fat (Loenneke, Wilson, Barnes, & Pujol, 2011). However, no weight loss restriction program has been implemented to limit the percentage of preseason to in-season weight loss. Over time, this fluctuation of weight and dehydration from pre-season to in-season could be harmful to the athlete and adversely affect wrestlers' athletic performance (Buford, Rossi, Smith, O'brien, & Pickering, 2006; Armstrong, Maresh, Gabaree, Hoffman, Kavouras, Kenefick, . . . Ahlquist, 1997). In addition, weight cutting has been shown to affect competitive performance, health, and normal growth in development (Oppliger et al., 1996).

Buford, Rossi, Smith, O'brien, and Pickering (2006) researched the effect of a competitive wrestling season on bodyweight, hydration, and muscular performance in collegiate wrestlers. Subjects consisted of 12 male NCAA Division I wrestlers from Oklahoma State University. Testing took place midseason and three weeks following the NCAA Division I Championships. The study found bodyweight increased 6.9% midseason to postseason, peak torque increased 28% midseason to postseason, and peak torque to bodyweight increased 19% midseason to postseason. These findings suggest that Division I college wrestlers have a significantly lower bodyweight from midseason to postseason and that strength loss midseason is related to the amount of bodyweight loss during the season. Since wrestlers were slightly dehydrated during midseason and postseason tests it has been determined to not be a significant factor for in-season strength. Weight-loss percentage preseason to post season has not previously been found to impact wrestling.

Wingate Test

A seven-minute wrestling match requires adenosine triphosphate (ATP) production from both the anaerobic and aerobic systems (Hübner-Woźniak, Kosmol, & Gajewski, 2009; Yoon, 2002; Mirzaei, Curby, Rahmani-Nia, & Moghadasi, 2009). In those seven-minutes, arm power and lower body power are applied both offensively and defensively; Furthermore, anaerobic power and capacity are important due to the short–duration and high intensity nature of a match (Horswill, 1992). Power in wrestlers is linked with quick and explosive movements that lead to success on the mat (Zi-Hong et al., 2013). The Wingate test has been used to reflect the maximum ability for a wrestler to generate power (Yoon, 2002). Hübner-Woźniak, Lutosławska, Kosmol, and Zuziak (2006) studied the effect of training experience on arm muscle anaerobic performance on 13 Polish senior wrestlers and 19 Polish junior wresters. Participants performed a modified upper-body Wingate test at 3.5% of wrestler's body mass. The wrestlers completed five rounds of 30 seconds of arm work followed by 30 seconds of rest. The senior wrestlers had significantly higher peak power output and power output in all five stages. Researchers suggested that the long-term training of senior wrestlers might result in higher phosphocreatine stores in the muscle as well as higher mean power outputs in all stages which would lead to an increase the anaerobic performance of upper body muscles and aerobic capacity. Senior wrestlers were also found to have a better aerobic capacity due to the higher level of lactate clearance.

García-Pallarés et al. (2011) suggested that lean body mass not aerobic capacity may contribute to wrestling success. Ninety-two elite and amateur male wrestlers were studied by weight class to determine if physical fitness factors can predict male Olympic wrestling performance. Wrestlers from five countries were brought in for an international week long training camp where all wrestlers averaged 9.6 training sessions. The standing Wingate test was performed on an adjustable Schoberer Rad Messtechnik (SRM) Indoortrainer. Subjects were instructed to crank as hard as possible for 30 seconds. The mean power, peak power, and lactate concentration were recorded. Elite groups recorded higher values in both mean power and peak power normalized to fat-free mass as well as having mean power relative to fat free mass. Light weight elite wrestlers mean power relative to fat-free mass had a 13% difference compared to amateur wrestlers (7.74 ± 0.86, 6.74 ± 0.80W/kg FFM). Light weight elite wrestlers had a 22% higher peak power compared to amateur wrestlers (630 ± 86, 492 ± 146W). Middle weight elite wrestlers' mean power relative to fat-free mass was 13.9% higher compared to amateur wrestlers (8.07 ± 1.40, 7.95 ± 1.08W/kg FFM). Middle weight elite wrestlers had a 17.6% greater peak power compared to amateur wrestlers (781 ± 154, 643 ± 140W). Heavy weight elite wrestlers' mean power relative to fat-free mass was 16% greater compared to amateur wrestlers (7.89 ± 1.07, 6.62 ± 0.67W/kg FFM). Heavy weight elite wrestlers had a 16.8% greater peak power compared to amateur wrestlers (902 ± 151, 750 ± 113W). There were no significant differences found between the elite groups. Researchers suggest that Wingate power is a strong determinant of wrestlers' success and that lean body mass may contribute to the wrestling success (García-Pallarés et al., 2011).

In 1997, Callan, Brunner, Devolve, Mulligan, Hesson, Wilber, and Kearney (2000) assessed the physiological characteristics of eight U.S. Freestyle World Team members. One assessment used a modified upper-body Wingate to mimic a five-minute wrestling bout. The mean peak power was 6.3 W/kg of bodyweight, average power was 3.5 W/kg of bodyweight, and the average power output declined from stage 1 to 5. Researchers suggest that the findings from the upper body Wingate test might be used to develop training strategies based on peak power, average power, and fatigue.

Handgrip Strength

Handgrip strength refers to the muscular force and strength generated by the hands (Bonitch-Góngora, Bonitch-Domínguez, Padial, & Feriche, 2012) and it is a commonly used measure of physical strength (Fink, Hamdaoui, Wenig, & Neave, 2010). A positive correlation has been shown between handgrip strength and weight, height, and sporting activities of an individual (Fink et al., 2010; García-Pallarés et al., 2011). Wrestlers during developmental years, when compared to non-wrestlers, have been found to exhibit a different pattern of age-related increases in absolute and relative handgrip strengths (Gerodimos, Karatrantou, Dipla, Zafeiridis, Tsiakaras, & Sotiriadis, 2013). In wrestling the ability to securely grab a wrist or create a body lock is an advantage. Takedowns, riding time, controlling and throwing your opponent rely on handgrip strength (Kraemer, Fry, Rubin, Triplett-Mcbride, Gordon, Koziris, . . . Fleck, 2001). Previous studies have agreed that handgrip strength is essential to the sport and it has been reported that isometric handgrip strength is a predictor of wrestling success (Kraemer et al., 2001; García-Pallarés et al., 2011).

Forty-two wrestlers from nine nations were studied examining muscle perceived exertion four weeks before the 1998 World Championship (Nilsson, Csergö, Gullstrand, Tveit, & Refsnes, 2002). Fifty-three percent rated high tension exertion in their forearms. These muscles flex the fingers and wrist and are active during gripping and stabilizing (Nilsson et al., 2002). García-Pallarés et al. (2011) compared elite wrestlers' dominant and non-dominant maximal handgrip strength to amateur wrestlers' maximal handgrip strength using a hydraulic dynamometer; results showed that in all three weight categories (light weight, middle weight, and heavy weight) elite wrestlers had a significantly higher dominant hand and non-dominant hand strength value compared to amateurs. Elite wrestlers also reported 6.3 %-18.9% higher isometric grip strength compared to the amateur wrestlers. Furthermore, as weight class increased in the elite wrestlers so did their dominant and non-dominant hands grip strength.

Physical and physiological differences between 48 Turkish wrestlers aged 18-20 were studied by Demirkan, Ünver, Kutlu, and Koz (2012). When comparing right hand and left handgrip strength between wrestlers selected for the national team (N=11) and team members not selected for the national team (N=37), results showed right handgrip strength for selected and non-selected team members were: 54 ± 8.0kg and 49 ± 8.0kg (t= -1.55, p= 0.12). Left handgrip strength for selected and non-selected were: 53 ± 7.8kg and 48 ± 7.9kg (t= -1.78, *p*= 0.08) (Demirkan et al., 2012). These findings supported those of García-Pallarés et al. (2011). Similarly, Mirzaei et al. (2009) found handgrip strength of Iranian junior wrestlers to be similar to those of an elite wrestler. Researchers conducted a research study with seventy elite junior freestyle wrestlers aged 18-20 from Iran. The purpose of this study was to provide wrestlers with a physiological baseline for a training program. Handgrip strength was measured using a handgrip dynamometer (Takei A5001). The best of three trials were recorded to the nearest kilogram. Results showed Iranian junior wrestlers selected for the national team squad have a higher left hand (selected: 53+7,8kg; not selected: 48+7,9lkg; t= -1,55) and right hand (selected: 54+8,0kg; not selected: 48+7,9kg; t=-1,78) grip strength compared to the junior wrestlers who did not make the national team.

Like wrestling, judo is a combat sport in which athletes use gripping techniques to hold and control their opponent. Bonitch-Góngora et al. (2012) studied the effect of lactate concentration on handgrip strength during judo bouts. Twelve male judo-athletes were used for the study. The athletes had been training at least 10 years and 10 were medalists in national champions while two were medalists in regional championships. The athletes participated in four 5-minute judo bouts with 15-minutes between bouts for recovery. A single measurement took maximal isometric handgrip strength pre and post judo bouts. Dominant hand, maximal isometric handgrip strength pre bout measured respectively: 575.85 ± 69.14; 525.24 ± 76.84; 528.35 ± 75.89N; and 527.29 ± 92.38N. Non-dominant hand, maximal isometric handgrip strength pre bout measured respectively: 554.26 ± 74.20; 517.97 ± 73.45N; 494.83 ± 68.03; and 490.58 ± 75.70N. Dominant hand, maximal isometric handgrip strength, post bout, measured respectively: 502.52 ± 57.03; 489.76 ± 71.84; 484.04 ± 88.22; and 489.27 ± 94.91. Non-dominant hand, maximal isometric handgrip strength post bout measured respectively: 495.89 ± 63.90; 480.28 ± 67.50; 477.26 ± 62.47; and 479.87 ± 59.78N. The dominant hand, isometric handgrip strength showed to be significantly higher than the non-dominant hand in pre bouts three and four. Dominant handgrip strength was higher than non-dominant handgrip strength for all bout numbers. The results from this study show that judo bouts significantly reduce the maximal isometric strength of both hands. Since aspects of a judo bout are very similar to a wrestling match, grip strength should be taken into consideration during a wrestling match or tournament. Isometric handgrip strength appears to be a significant factor of wrestling success (Bonitch-Góngora et al., 2012).

Lower Body Power

Studies have shown the vertical jump protocol to be a reliable method to evaluate lower-body muscular power (Callan et al., 2000). Lower body muscular power is important in a wrestling match whether hitting an explosive shot, lifting an opponent, resisting a move, or firing off a powerful stand up (Callan et al., 2000). Callan et al. (2000) studied the physiological profiles of eight elite freestyle wrestlers on the United States freestyle wrestling team. The testing was completed in one day and measured: body composition, lower-body muscular power, upper-body muscular power and endurance, flexibility, anaerobic power, and aerobic power. The Vertec was used to evaluate lower-body muscular power. The highest number of three attempts was recorded. The jump height was calculated vertical jump = maximal jump height - initial reach height. The team average for the vertical jump was 60 ± 10 cm (49.5-87.6) which supports the importance of lower-body power and suggests that athletes who do not have a high degree of lower body strength will need to adjust their wrestling style to compensate.

Kraemer et al. (2001) studied the physiological and performance effects of a two-day Freestyle wrestling tournament on 12 male Pennsylvania State University wrestlers. Subjects were instructed to lose 6% body mass the week leading up to the competition. Wrestlers weighed in about 12 hours before wrestling on day one. By competition time on day one, wrestlers gained back 1.8% of their bodyweight and on day two, they were only allowed a 2% weight allowance. Wrestlers had three matches on day one and two matches on day two. Tests took place immediately before and after the matches. Leg power was determined with a vertical jump on a force platform. Each subject performed three trials on a force platform, with the highest peak power being recorded. Results showed vertical jump power on day one of matches was not significantly different from the baseline values, but from day two preceding to the fourth match, the mean value was significantly lower (4318.49 ± 344.09W). The authors concluded that tournament wrestling impacts physical performance throughout a tournament, one of these impacts being lower-body power.

Speed

Researchers have found sprint speed to be a quality of a wrestler and a physical factor that predicts wrestling success (García-Pallarés et al., 2011; García-Pallarés et al., 2012; Mirzaei et al., 2009). García-Pallarés et al. (2011) found sprint speed to be an attribute of a wrestler, however, it was not directly related to wrestling performance. Researchers reported no significant differences between two 10-meter sprint running times of 92 male wrestlers, elite wrestlers (N=46) and amateur wrestlers (N=46). Wrestlers were assigned a group based on body mass: light weight (between 55- 68 kg) elite (N=18) and amateur (N=15); middle weight (between 68- 84 kg) elite (N=18) and amateur (N=19), heavy weight (between 84- 100 kg) elite (N=10) and amateur (N=12). However, the elite group reported faster times for light, middle, and heavy weight: 1.08 ± 0.06, 1.76 ± 0.06, 1.76 ± 0.10 seconds respectively. The amateur group's scores by light, middle, and heavy weight were reported as 1.84 ± 0.10, 1.81 ± 0.10, 1.88 ± 0.11seconds respectively. The percent difference between the elite and amateur light weight group was -2.2%; between the elite and amateur middle weight group was -2.8%; and between the elite and amateur heavy group was -6.8% with the faster times favoring the elite athletes. Based on these findings, researchers suggested that sprint speed should be considered an attribute of a wrestlers but not directly related to wrestling and that future studies should examine other speed components of wrestling (García-Pallarés et. al., 2011).

García- Pallarés et al. (2012) conducted a similar study comparing elite and amateur female wrestlers and found female wrestlers' 10 m sprint speed was not related to performance. The times for the elite group of light and middle weight wrestlers were: 2.05 ± 0.05 and 2.01 ± 1.04 seconds respectively. The times for the amateur group of light and middle weight wrestlers were 2.08 ± 0.10 and 2.06 ± 0.05 seconds respectively. The percent difference between elite and amateur light weight group speeds was -1.5% and between the elite and amateur middle weight group speeds was -2.5% in favor of the elite group. However, these results were not significantly different. In wrestling, speed is the rate at which a wrestler is able to move on the mat. In competition, a wrestler is not sprinting on a straight away. Since a sprint is not specific to the sport, testing the shot velocity would be a more accurate measurement of success.

Velocity measures the rate of change of distance per unit of time in a given direction (McArdle, Katch, & Katch, 2011). For maximum specificity of training, the athlete's movement and training patterns during exercise should closely resemble those used when performing the sport. Currently, no published studies have measured the shot velocity of a wrestler.

CHAPTER THREE: Methodology

Subjects

Approximately 25 wrestlers were recruited from the University of Central Oklahoma's (UCO) wrestling team. Of these 25 recruited, nine participated, and six met the criteria to be included in the final data set. The researcher received verbal approval from Head Coach James to contact wrestlers on the 2015-2016 wrestling team. All wrestlers were familiarized with the five testing variables, testing procedures for each variable, and the design of the study. The subjects and coaches were informed in detail about the experimental procedures and the possible risks and benefits of the program. All subjects were provided with an informed consent form to participate in the study (Appendix A). The athlete's participation was voluntary for the duration of the study. There was a scheduled pre-testing meeting to cover all of the details of the study and to inform the subjects of the step by step process of the study.

The inclusion criterion pertained to the subject's age, gender, current wrestling status, wrestling match participation, and health status. Subjects were between 18 to 25 years, male, currently participating on UCO's wrestling team, and had wrestled a minimum of eight matches in the season. Pre-established nutrition plan, weight class division, hydration level, and training schedule were followed according to coaching staff and trainer's orders.

The independent variables for this study included percent bodyweight change (preseason to in-season), Wingate anaerobic test results using an arm ergometer, shot velocity, handgrip strength of the non-dominant hand, and vertical jump. The dependent variable for this study was percent wrestling wins.

Test Design

After approval, subjects signed up for a testing time slot. Testing took place in November, 2015, during wrestling season. Athletes were randomly assigned to a test order for the vertical jump, non-dominant handgrip strength, and shot velocity. Due to the power needed for the Wingate test, every athlete performed this test last (Appendix B). Testing did not take place the day before, the day of, or the day after a competitive wrestling match. The inclusion criteria information was discussed at the volunteer meeting with the participants.

Percent Bodyweight Change.

Each athlete's percent bodyweight change was evaluated by recording the first official preseason weigh-in weight and recording the weight they weighted the day of testing. Weight was expressed in kilograms. Percent weight change was formulated by subtracting in season weight from preseason weight and multiplying by 100 (preseason weight - in season weight) X 100 = percent weight loss).

Wingate Test Procedures.

The Wingate test is used to measure peak anaerobic power. All subjects performed a 30 second Wingate test using an arm crank ergometer. Subject was seated in a chair with feet flat on the ground. The subject performed up to a three minute warm up with no load. After the warm up the subject had the opportunity to do three minutes of dynamic stretching. Subject was instructed to go as fast and hard as possible for 30 seconds. Subject got a 3-2-1- 'go' countdown. All subjects had a constant resistance on the Wingate, number of resolutions in 30 seconds was counted and recorded.

Shot Velocity Test Procedures.

Shot velocity was measured using the Tendo Power Analyzer Unit. The Tendo Power Analyzer Unit is resistance free, has a retractable strap, and measures 2.8 meters range of motion. When the retractable belt is pulled it measures velocity, force, and power. The Tendo

Power Analyzer Unit mat was placed on the wrestling mat. The athlete was given 10 minutes to warm up. He was instructed to warm up for a double legged shot. Observer watched to see which leg was his lead leg for shooting. After the warm up, the Tendo Power Analyzer Unit's strap was looped slightly above the malleoli of the lead leg. The athlete got in shot position. The test consisted of three double legged shot attempts with a 30 second minimum rest between each test. The maximum shot velocity of the three attempts was recorded.

Maximal Handgrip Strength Test Procedures.

Each subject's handgrip strength was measured for his non-dominant hand using the hydraulic dynamometer. In wrestling, grip strength allows a wrestler to control their opponents' wrists and every movement passes through the hands. The stronger the hands, the stronger the holds will be. For this reason, non-dominant hand was tested because it is the weaker of the two. Each participant identified his "strong hand" in wrestling. Participants were instructed how to use the hydraulic dynamometer then performed three familiarizing trials. The test was performed in a seated position with forearm and wrist in a neutral position, 0° shoulder flexion, and 90° elbow flexion. Both feet remained flat on the ground with knees bent at 90°. All subjects were instructed to squeeze the dynamometer as hard as possible for five seconds. Subjects were informed when to start and when the five seconds was up. A minimum of one-minute rest was measured between each trial. The maximum isometric contraction was recorded.

Vertical Jump Test Procedures.

Lower body muscular power was evaluated via a vertical jump protocol using the Vertec. Subjects were allowed up to five minutes to warm up. The Vertec was adjusted to the height of the participant's standing reach. The standing reach was determined by the athlete holding both hands above head with shoulders elevated upward reaching as high as possible. Once their hands were as high as possible above their head, the athlete walked under the Vertec and knocked away as many pegs as possible. The Vertec was then adjusted to the height measured with the highest peg pushed away being the first peg height. Athletes were instructed to stand directly under the Vertec and to focus on the highest touch point on the Vertec. The athlete loaded down rapidly; lowering their legs and threw arms back with shoulders in hyperextension as though they are two springs. Then, each athlete explosively jumped vertically using one hand to push away the highest peg possible. Athletes were allowed up to five practice attempts. Following the practice attempts, each athlete made three jump attempts with a minimum of one- minute to recover. The highest of three jumps was recorded. Vertical jump = jump height- initial reach height.

Statistical Analysis

Due to the statistical test being ran, no sample size or effect size was estimated; however, in order to maintain the strength and validity of the statistical test, 3-5 variables were suggested on a population of approximately 25 participants. The study was approved by the UCO Institutional Review Board for final approval (Appendix C). Data was reported as mean +/- standard deviation and analyzed using SPSS statistical software version 19.0. The multiple regression statistic generated a correlation matrix for all the independent variables as well as the dependent variable. The multiple regression followed a stepwise progression. Statistical significance was set at $p < 0.05$.

CHAPTER 4: Results

Descriptive Statistics

The means and associated standard deviations from the dependent and independent variables are shown in Table 1. Of the six wrestlers, three gained and three lost mass.

The overall model, Model 1(Table 2), showed an R value of .838 with R^2 of .702. Additionally, the overall model was significant with an F = 9.402 and $p = .037$. Only one independent variable (percent change in weight) correlated significantly with the dependent variable, therefore Model 1 only includes this single independent variable. Thus, percent change in bodyweight showed the same R, R^2, F, and *p* values as the overall model (Table 3). Based on R^2 of .702, then 70.2% of the influence in changed body mass predicted success in wrestling ($r = 0.838$, $R^2 = 0.702$) indicating a positive relationship between an increase in body mass and season wins.

The regression equation shows that wrestlers who gained mass were more likely to win compared to those who did not. Using this prediction formula, every 1 kg increase in body mass would result in a 1.507% increase in wins per wrestling season (Figure 1). The regression equation would be: $\hat{y}$ (predicted wins) = 62.148 + 1.507kg (weight change in kg).

Researcher rejected the null hypothesis for the overall model, percent weight change ($p < 0.05$) and failed to reject the null hypothesis for the 30-second maximal arm cranking ($p > 0.05$), shot velocity ($p > 0.05$), vertical jump ($p > 0.05$), and handgrip strength ($p > 0.05$).

CHAPTER 5: Discussion

The purpose of this study was to examine if there are attributes of male Division II collegiate wrestlers that can predict success in competition. In general, the athletes were very fit due to the fact that testing took place in season. Two of the tested wrestlers placed in the top four at the NCAA Division II West Regional competition and qualified for the NCAA Division II Championships. Neither of the two wrestlers placed at the NCAA Division Championships.

Prior research reports that in season wrestlers have between 3 to 13 percent body fat (Wilmore, Brown, & Davis, 1977). Body composition and hydration levels have been shown to affect performance but no relationship appears to exist between the level of wrestling success and the percent of body fat (Horswill, 1992). However, with diminish body mass, this could result in poor hydration and low energy nutrients availability resulting is poor performance.

It is possible that the increase in weight gain evident in this study could have led to the improved torque output. In 2008, Buford, Smith, O'brien, Warren, and Rossi studied 12 wrestlers from the Oklahoma State University's NCAA Division I national champion team and reported their bodyweight (kg) was significantly lower during mid season competition (75.11 ± 3.53kg) compared to bodyweight (kg) gained post season (80.30 ± 0.2.98kg) with a mean of 6.9% gained from mid-season to three weeks post season. As their weight decreased mid-season, their peak torque also decreased (182.76 ± 9.63N·m). Furthermore, as their bodyweight increased post season, their peak torque significantly increased (233.57 ± 7.75N·m). Wrestlers reported being dehydrated at both mid-season and post season testing, which suggests that strength losses were most likely related to the amount of bodyweight lost during a season. This might provide insight into the current study's findings. Therefore, the current study can further substantiate the relationship between strength and weight, though caution must be used when interpreting the results. Bodyweight has a powerful influence on percent wins, however, torque, hydration status, and percent body fat were not assessed in this study. In addition, it is possible that weight gain could be most beneficial for those who are light for their weight class. This would seem to occur more often for those who are underweight while competing in the heavy weight category (83.01kg- 129.27kg). Interestingly, in the current study 1/3 of participants wrestled heavy weight and reported being under 129.27kg the day of testing.

Shot velocity does seem to be important but was not a significant variable. The researcher knows that acceleration when shooting a leg attack is dictated by ground reaction force, and body mass. In addition, results could have been different with a larger test population, or with wrestlers that have a greater success level. Potentially speed and managing weight are both important factors. It is possible that the reason shot velocity was not a significant predictor was due to the retractable strap from the Tendo unit being attached to the lead foot and not closer to the center of mass (the hips). The displacement would perhaps have been different for the hips as opposed to the lead foot in the same time interval, although this is not a certainty without further research. A third of the test subjects were heavyweights and with increased inertia there is a decrease in velocity. That means it is possible that the heavy weight wrestlers do not rely on shooting as much as lighter weight wrestlers. This combined with the low subject numbers and the absence of wrestlers that have a high success level could better explain why shot velocity was not found to be significant.

Interestingly, two of the three wrestlers with the highest vertical jump heights qualified for NCAA Nationals. It is important to note that the lightest weight class represented in the current study was 67.58kg, which means three of the lighter weight classes were not represented in this study. Had these weights been represented, there might have been different results. Light wrestlers have a lower inertia and would most likely have been faster and more likely to rely on speed for success compared to their heavier counterparts.

Despite previous studies indicating handgrip to be a vital performance capability in the sport of wrestling and that isometric handgrip strength to be a predictor of wrestling success (Nilsson et al., 2002; Kraemer et al., 2001; García-Pallarés et al., 2011), this study did not show grip strength to be a significant contributor of wrestling success. Handgrip strength seems to be a common attribute of wrestlers since it has been shown that their grip strength tends to be greater than that of other athletes (Gerodimos et al., 2013). A potential reason that it was not a significant variable is that grip strength did not seem to vary much amongst them. With the exception of one outlier (much higher than everyone else's), all the scores were within 8kg regardless of weight class. Therefore, this was not a distinguishing feature. However, with a larger test population, or wrestlers with a greater success level, the findings could possibly show some of these predictor variable to be significant.

Based on previous research, peak anaerobic power (expressed by using the arm-crank ergometer in this study), seemed to be an important testing variable but it was not significant in the current study. Hindsight suggests that the wrestlers should have had a day or two to familiarize themselves with maximal arm cycling; this familiarity could have changed the reported relationship. In addition, the researcher was unable to adjust the resistance on the ergometer, thus resistance was set at an absolute constant value for all weight classes. Furthermore, Hübner-Woźniak et al. in 2006 did test arm cycling at 3.5% of bodyweight. If the equipment needed was available to adjust the resistance, the results might have been different.

The purpose of the study was to determine if there were physiological attributes of wrestlers that predicted wrestling success. There are several factors that could have contributed to the lack of additional significant variables found in this study. The first one would be that there was a small sample size. A larger sample size could have changed the outcome and possibly resulted in more significance. One wrestler that reported the highest shot velocity, highest vertical jump, highest revolutions on the Wingate, reported the highest weight gain of 5.26kg, and was not a national qualifier but did have a 31-11 record. As mentioned above, this study did not represent all weight classes. A broader range of weight classes could have also impacted the results. The study consisted of no national placers and there were only two who qualified for nationals. The statistical outcome could have been different if there was a more successful sample population as well as more subjects. Lastly, the findings could have been different if the wrestlers would have been tested throughout the season.

Conclusion

In this study, the influence of five attributes of a wrestler were evaluated, for the purpose of identifying if an attribute can have an impact on wrestling wins in a competitive season. The results showed only one independent variable, percent change in weight, to be correlated significantly. Despite only one variable being significantly correlated, the results still offered insight for current wrestlers and direction for future research. Future studies should test a larger and broader population of wrestlers, as well as consider testing wrestlers throughout the season. Other suggestions for future research include: designing an anaerobic testing protocol for the arm crank that adjusts the resistance based on the wrestler's weight; allowing wrestlers to have a couple of days to familiarize themselves with the novel equipment being used for testing; measuring body fat percentage and hydration level as oppose to weight change, and looking further into the best attachment point (foot or hips) to measure shot velocity. In addition, though not found to be significant, it must be noted that two out of the three top performers for shot velocity, vertical jump, and arm crank revolutions, had the most overall wins, at 31 each. Also, these two wrestlers, as expected, gained weight. For wrestlers, weight gain in the form of lean muscle mass could result in more powerful, and stronger wrestlers. Based on the current findings, speed and lower body power appeared to be attributes of the wrestlers with most wins. However, it is possible that different weight classes require varying degrees of these attributes. Thus, knowledge of the neurological and physiological strengths of successful wrestlers at all weight classes could better help coaches and trainers enhance physiological attributes and skills.

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Table 1

Mean and Standard Deviation for Predictive Variables

Variables	N	Mean	Standard Deviation
% season wrestling wins	6	64.36	7.44
% bodyweight change	6	1.47	4.14
Shot velocity (m/s)	6	5.29	1.48
Non-dominant hand handgrip strength (N)	6	519.26	6.16
Vertical jump (m)	6	.631	.11
Arm cranking for revolutions in 30 seconds	6	92.50	9.98

Table 2

Model Summary

Model	R	R^2	F.	df1	df2	Sig.
1	.838	.702	9.042	1	4	0.37

Table 3

Correlations of Independent Variables WithPercent Season Wrestling Wins

	% bodyweight change	Shot velocity (m/s)	Non-dominant hand handgrip strength (N)	Vertical jump (m)	Arm cranking for revolutions in 30 seconds
R value	.838	.649	-.036	.780	.312
t value	3.066	1.936	1.288	-.075	.757
**p* value	.037	.148	.288	.219	.504
R^2	.072	.421	.001	.608	.097

* = $p < 0.05$

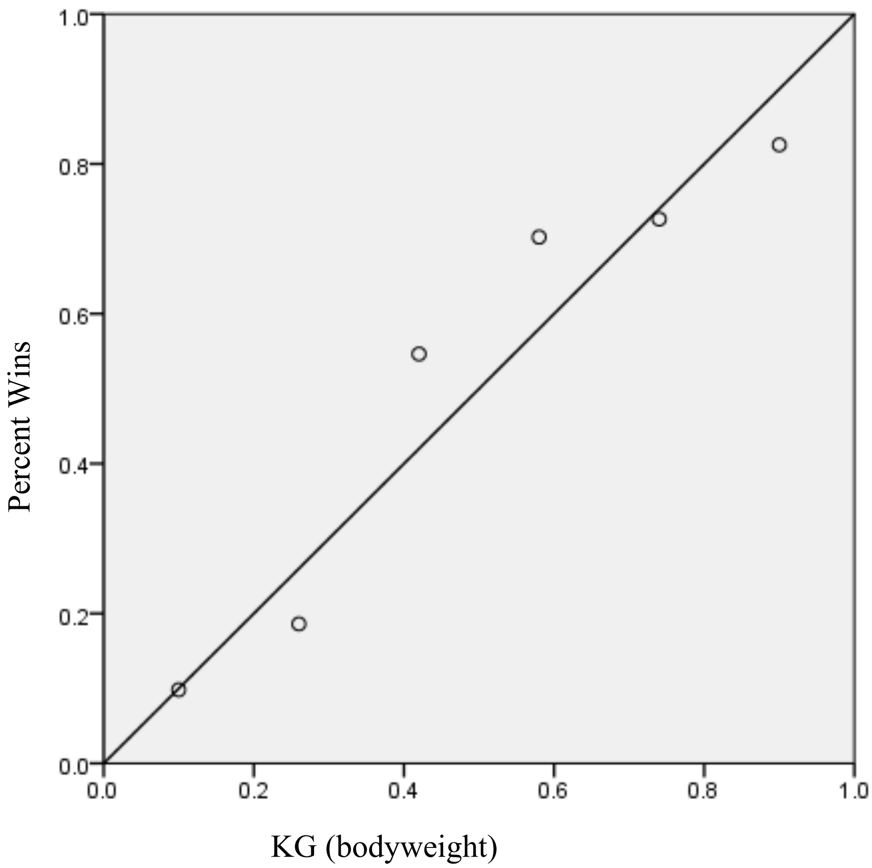

Figure 1. Line graph of the relationship between percent change in body mass and percent wins.

Appendix A

Informed Consent Form

Informed Consent

Title: Predictor variables for success in college wrestling

Principal investigator: Shea Ware

It is imperative that you read, understand, and sign this informed consent form prior to participation in this study. The intent of this document is to inform you of the purpose, procedures, potential benefits, risks, and discomforts of participating in this study. Additionally, participation in this study is of a volunteer nature and it is your right to withdraw from the experiment at any time and for any reason without penalty. Finally, there is no certainty as to what the outcome of the study will be.

Purpose: The purpose of this study is to determine if one of the five attributes (percent body weight loss, peak anaerobic power, shot velocity, isometric hand grip strength and lower body muscular power) can mathematically predict wrestling success in the form of percent wins during a competitive season.

Subjects: We are looking for volunteer participants for this study. Subjects will be student volunteers from the wrestling team at the University of Central Oklahoma. The premise and recruitment of the study will be presented by a Graduate Assistant from the Kinesiology and Health Studies department at the University of Central Oklahoma. All subjects must be cleared through the University of Central Oklahoma's athletics physical.

Group: All the subjects will be tested on percent body weight loss, arm cycling, shot velocity, hand grip strength and vertical jump height. All subjects' first certified preseason weight will be shared by Coach Kyle Evans to determine percent body weight loss. All subjects will participate in a 30 second Wingate arm crank to measure peak anaerobic power. Each subject will perform a double legged shot to measure shot velocity. Each subject will participate in a vertical jump to measure lower body muscular power. Each subject's hand grip strength will be measured using the Hydraulic Dynamometer.

Testing and training procedures:

- **Percent body weight loss**
  - Coach Kyle Evans will share subject's first certified preseason weight.
  - All subjects will be weighed (while dressed in the clothes they will perform the tests in) the day of tests.
- **Wingate test-arm crank**
  - During the seated 30 second Wingate arm crank test, peak anaerobic power will be determined via arm ergometer.
  - Subject will be seated in a chair with feet flat on the ground.

- Once subject is at maximum speed a load of 0.05 kilograms per kilogram of bodyweight will be added as a resistance and then the subject will be instructed to go as fast and hard as possible for 30 seconds.

- **Shot velocity**
  - During the shot velocity test, subject will be tested on the velocity of a double legged shot via HUMAC 360.
  - After the warm up, the HUMAC 360 strap will be looped securely around the ankle.
  - The HUMAC 360 has a 16' resistance free, retractable nylon belt.
    - This is a devise capable of measuring velocity by simply pulling an unweighted belt out of a box that it is coiled up into.
  - The test will consist of three double legged shot attempts.
- **Maximal handgrip strength**
  - During the maximal handgrip strength test, isometric grip force will be measured for the non-dominate hand using the Hydraulic Dynamometer.
  - The subject will be instructed how to use the hand dynamometer then perform three preliminary warm up trials in order to become familiar with the tool.
  - The test will be taken in the seated position.
  - Subject will squeeze the dynamometer as hard as possible for five seconds.
  - The test will consist of three attempts.
- **Vertical jump**
  - During the vertical jump test, lower body muscular power will be evaluated via the Vertec.
  - The Vertex is one of the most common apparatus for measuring vertical jump ability. It is a steel frame construction with horizontal vanes which are rotated out of the way by the hand to indicate the height reached.
  - Subject will warm up jogging or riding a bicycle for five minutes followed by ten submaximal vertical jumps.
  - The Vertec will be adjusted to the height of the participant's initial reach length.
  - Subject will load down rapidly lowering his legs and throwing arms back and explosively jump vertically using one hand to push away the highest peg possible.
  - The test will consist of three attempts.
- All subjects will be tested in Hamilton Field House at the University of Central Oklahoma.
- To control for learning affects, all subjects will have time to warm up and practice prior to tests.

Warm-ups:

Wingate test- arm crank

- Subject will perform a 3 minute warm up with no load.

- **HUMAC 360- shot velocity**
  - Subject will be given 10 practice double leg shots.

- **Maximal handgrip strength**
  - Subject will be instructed how to use the hand dynamometer then perform three preliminary warm up trials.

- **Vertical jump**
  - Subject will warm up by performing ten submaximal vertical jumps.

Benefits: Participation in this study contributes to discovering potentially the most effective attributes a wrestler must bestow for success in wrestling. This new knowledge could apply not only to wrestling.

Risks: It is common to experience arm, shoulder and chest fatigue during the 30 second Wingate test and possible to experience muscle soreness the following 3-4 days. While it is not anticipated, it is possible to experience a shoulder, elbow, wrist, or hand injury during the handgrip strength test and the arm cycling. In addition, it is possible to experience back, hip, ankle, leg, or knee injury during the shot velocity and vertical jump tests.

In case of serious illness or injury resulting from this study, 911 will be called to provide emergency medical treatment. No funds have been set aside by the University of Central Oklahoma to compensate you in the event of illness or injury

Let it be known that will take every precaution to insure that participants are not injured, but that they will assume liability and should seek their own medical treatment.

Questions: If you have any questions regarding your participation in this study you may contact Shea Ware (Principal investigator) at (405) 974-3119 before and/or after signing the consent form. If you have any additional questions regarding your rights you can contact UCO IRB at (405) 974-5497. I ___________________understand and agree to the above and
(Print Name)
affirm that I am at least 18 years old.

_______________________________ _______________________________

Participant's Signature Date Researcher's Signature Date

Appendix B

Data Collection Sheet

Data Collection Form

Name: ____________________________ Assigned #:________________________

Date of birth: _______________________

Weight:

Weight (preseason): ________________ Weight (11-11): ________________

Shot Velocity: ___________

1.___________ 2. ___________ 3. ___________

Maximal handgrip strength: ___________

1.___________ 2. ___________ 3. ___________

Vertical jump: ___________

1.___________ 2. ___________ 3. ___________

Wingate: ___________

1.___________ Revolutions

Notes:

Appendix C

IRB Application Approval

October 9, 2015 IRB Application #: 15153

Proposal Title: Predictor Variables For Success In College Wrestling

Type of Review: Initial-Expedited

Investigator(s):
Ms. Shea Ware
Dr. Paul House
Department of Kinesiology & Health Studies
College of Education & Professional Studies
Campus Box 189
University of Central Oklahoma
Edmond, OK 73034

Dear Ms. Ware and Dr. House:

Re: Application for IRB Review of Research Involving Human Subjects

We have received your materials for your application. The UCO IRB has determined that the above named application is APPROVED BY EXPEDITED REVIEW. The Board has provided expedited review under 45 CFR 46.110, for research involving no more that minimal risk and research category 7.

Date of Approval: 10/9/2015
Date of Approval Expiration: 10/8/2016

If applicable, informed consent (and HIPAA authorization) must be obtained from subjects or their legally authorized representatives and documented prior to research involvement. A stamped, approved copy of the informed consent form will be sent to you via campus mail. The IRB-approved consent form and process must be used. While this project is approved for the period noted above, any modification to the procedures and/or consent form must be approved prior to incorporation into the study. A written request is needed to initiate the amendment process. You will be contacted in writing prior to the approval expiration to determine if a continuing review is needed, which must be obtained before the anniversary date. Notification of the completion of the project must be sent to the IRB office in writing and all records must be retained and available for audit for at least 3 years after the research has ended.

It is the responsibility of the investigators to promptly report to the IRB any serious or unexpected adverse events or unanticipated problems that may be a risk to the subjects.

On behalf of the UCO IRB, I wish you the best of luck with your research project. If our office can be of any further assistance, please do not hesitate to contact us.

Sincerely,

Robert Mather, Ph.D.
Chair, Institutional Review Board
NUC 341, Campus Box 132
University of Central Oklahoma
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