

**EXTERNAL DOPING EFFECTS IN COMPETITIVE WEIGHTLIFTING**

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**Abstract:**

This study uses results from the International Weightlifting Federation world championships to examine the peer effects of doping in competitive weightlifting. The sport of weightlifting provides a controlled environment and an objective measure of performance, as well as an abundance of positive drug test results to analyse how athletes respond to the expulsion of their peers from competition. Athletes can foresee a change in competition due to doping and modify training behaviour or drug use accordingly. I find that the doping level of an athlete's direct competitors is negatively related to performance.

## Introduction

Doping has become an increasingly pressing topic in sports, specifically those involved in the Olympic Games. The recent doping scandal surrounding the 2014 Sochi winter games in which Russia was allegedly providing performance enhancing drugs to athletes and somehow bypassing drug tests, has given rise to a call for larger doping penalties for athletes and countries. Weightlifting specifically has been under fire from the International Olympic Committee. Positive drug test results for international level weightlifting athletes range from 50-100 per year in the past decade, surpassing cycling for the largest number of positive test results. However, the International Weightlifting Federation has done little to combat the record number of doping athletes. The average penalty for a weightlifter caught doping is two years, which is significant relative to a weightlifter's career length. However, this form of sanction is clearly inadequate to significantly reduce doping cases.

There is evidence suggesting that peers can have a significant impact on the level of an individual's performance. Brown (2011), studying the PGA golf tour, has shown that players in direct competition with Tiger Woods performed significantly worse than their average level of play, and their performance dips further as Tiger Woods' play increases. Hickman and Metz (2018) find that professional golfers learn from their peers, which has a positive impact on performance. However, like Brown, they find a negative relationship between an individual's play and the performance of peers. Smith (2013) analysed the Scripps National Spelling Bee and found that when a student spelled a word correctly, the following student was significantly less likely to spell their word correctly. Guryan, Kroft, and Notowodigdo (2013) also studied

golfers competing on the PGA tour and contrary to Brown and Hickman and Metz, did not find any evidence that playing partner ability influenced performance.

This paper investigates how the performance of an individual is affected by peer athletes being caught doping. Using data from the Weightlifting world championships throughout the period 2008-2016 as well as data on the level of doping that occurred throughout this time frame, I estimate the effect that the level of doping throughout the previous year has on an individual's performance at the world championships. I find that high levels of doping amongst an athlete's competitors reduces performance significantly.

The setting of the International Weightlifting Federation world championships provides a highly controlled environment to test the effect of doping on competitors' performances. Whereas other sports with prominent doping issues, such as cycling, present additional challenges due to external factors.<sup>1</sup> Although weightlifting is highly technical, it is a strength-based sport.

Naturally, the temptation to use performance enhancing drugs is especially significant due to the potentially higher return relative to other sports. The large number of positive test results each year creates a variation in the level of competition that a weightlifter is facing. I hypothesize two channels through which the lifter may be affected by the doping of competitors: first, the lifter's effort responds to the change in direct competition positively or negatively. Second, the lifter modifies drug use in response to either the level of competition they face or how they perceive their chances of being sanctioned.

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<sup>1</sup> The measure of performance in cycling is time, which varies greatly with factors such as course length, wind speed and direction, the number and difficulty of climbs and descents, terrain, and other weather factors.

## Conceptual Framework

Brown (2011) has shown that individuals competing against Tiger Woods in golfing tournaments performed significantly worse than they otherwise would. This finding suggests that in the face of higher level competition, individual performance declines. However, Kroft, Guryan, and Notowodigdo (2013) found no evidence of this “superstar effect” when analysing playing partner ability and performance of PGA tour golfers. While there is conflicting evidence from the PGA tour, competition or pressure can be a driving force in an individual’s performance. How an individual responds to competition and/or pressure determines whether there is a positive or negative effect.

In competitive weightlifting, there are multiple mechanisms through which the level of doping could influence performance of unsanctioned athletes. Top level athletes caught doping significantly reduces the level of competition faced by an athlete, since the doper is no longer eligible for competition. Thus, the higher the number of athletes failing drug tests in a given year, the lower the level of competition that an athlete faces. Should athletes behave like Brown (2011), we would expect the level of performance to be increasing with the number of dopers, since the probability of winning increases. Athletes may also respond positively to competition, where high-quality competitors push their peers to perform better. In this case we would expect a negative relationship between the number of dopers and level of competition.

While the peer-effects due to varying competition may be most evident, athletes may modify drug use in response to the doping of their peers. Due to the large number of weightlifters that

test positive each year, a significant portion of the field could be doping but are yet to fail a drug test or receive sanction. Those athletes that have not yet been caught may recognize the increased probability of being tested once their peers have been sanctioned and reduce drug use, leading to potentially lower performance. Athletes may also recognize an increased probability of winning should their peers test positive, leading to higher risks taken in training and increased drug use.

More formally, athletes choose effort (e.g. training hours) and doping intensity to maximize their objective, performance (e.g. total weight lifted) net of the cost of doping. One can also imagine that cost of doping depends on the perceived probability of being caught. The objective function depends on (at least) three factors: effort, doping intensity and peer effects. In this framework, an increase in the number of competitors caught doping effects total weight lifted directly and indirectly. The direct effect is the effect of a change in the composition of the pool of competitors on performance (e.g. through the effects of higher or lower pressure performance). The indirect effects come from the effect of a change in the composition of the pool of competitors on the choice variables, effort and doping intensity.

### **Data and Descriptive Statistics**

The goal of this paper is to estimate the effect that the number of athletes caught doping in a given year can have on performance. To do so I have elected to use data from the highest level of weightlifting competition that exists; the International Weightlifting Federation (IWF) world championships. External doping effects may be present and important at lower levels of

competition; however, one would expect more instances of doping and thus a potentially more significant change in behaviour of competitors at a level where stakes are highest.

Each year, the world's top competitors contend for the title of World Champion, and while there may not be any direct compensation for performance, placing at high level competitions is often used to determine an athlete's stipends. Moreover, the world championships are important qualifying events for the Olympic Games; the athlete's ultimate goal. The level at which countries perform at the world championships in the years leading up to the Olympics essentially determines the number of athletes a country can send to the games. While the qualifying standards are slightly stricter than the world championships, the structure is essentially the same, so I make little distinction between the two events.<sup>2</sup> Each country has an incentive to send their best athletes and athletes have an incentive to perform at their highest level in search of future international team placings, monetary compensations, as well as world record titles.

The data that I have collected consists of world championships data from the years 2008-2016, covering three Olympiads: the 2008 Beijing Games, the 2012 London Games, and the 2016 Rio Games. The data consists of a measure of each athlete's performance in each year: total weight lifted.<sup>3</sup> The dataset also comprises important information about the athletes such as age, weight class, and gender.

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<sup>2</sup> The world championships and Olympic Games do not take place within the same year so they both represent the largest competition of a given year.

<sup>3</sup> Weightlifting consists of two lifts: the snatch and the clean and jerk. The total is sum of the two and determines overall placing.

Tables 1, 2 and 3 present summary statistics. Approximately 57 percent of the sample consists of males. Typically, male athletes lift considerably more than females. The average total (two lifts) for males is 331 kilograms, while the average for females is 209 kilograms. The measure of total varies greatly within gender groupings as well, due to differences in bodyweight. The average age for men and women is approximately the same at 24 years.

To construct the variable of interest, which will serve as an indicator of the level of doping in each year, I have drawn data from the World Antidoping Database. The World Antidoping Database publishes all positive drug tests in any sporting event under the surveillance of the World Antidoping Agency. The World Antidoping Agency (WADA) conducts drug testing of athletes worldwide through its many national subsidiaries. Athletes are drug tested both in and out of competition. The frequency of the testing depends on the caliber of the athlete as well as how actively the athlete is competing. Athletes competing at the world championships and the Olympic Games are therefore under much higher scrutiny from WADA than lesser athletes. Nonetheless, many athletes competing in lower level competitions contribute to the total number of doping cases. I cross-reference the athletes that have tested positive according to the World Antidoping Database with those competing on the international stage to isolate the highest level of athletes in the dataset.

I construct a variable *dope* as a dummy variable that indicates whether an athlete has failed their respective drug test. Within this sample, 11 percent of the athletes consist of those that have failed a drug test. To tease out an effect of the number of dopers on performance level, I compare athletes only in direct competition with each other by creating the variable *dopers*

which indicates the number of athletes that have failed a drug test in a given competition year<sup>4</sup> and weight class. On average, this number is 2.85 for both genders, 3.37 for males and 2.13 for females, i.e. in each year and weight class, there are nearly three positive drug test results.

This variable varies greatly between years and weight classes, ranging from 0 to 12.

### Identification Strategy

There is a literature investigating peer-effects in sports and how competition may indirectly affect an individual's performance. However, to my knowledge no paper has investigated peer-effects with respect to doping. Thankfully, weightlifting competitions provide a highly controlled environment to conduct such an analysis. Golf tournaments, as studied by Brown (2011), Hickman and Metz (2017), and Guryan, Croft, and Notowodigdo (2013), are subjected to external factors such as rain, wind speed and direction, and course difficulty, which impact a golfer's performance. Whereas a weightlifting competition takes place indoors, with the same equipment and standards as previous years. Therefore, few external factors need to be considered. The largest variation in performance will be due to differences in gender, weight class, and training experience. The first two are easily found as variables in the dataset, while age will serve as a proxy for experience.

I employ a simple linear probability model to estimate the effect of the level of doping on individual performances:

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<sup>4</sup> Competition year refers to the period lead up to the current year's world championships, after the last year's championships.

$$Y_{ijt} = \alpha_i + \gamma_t + \beta \text{dopers}_{j,t-1} + x'_{it}\lambda + \varepsilon_{ijt},$$

where  $Y_{ijt}$  represents the total weight lifted of individual  $i$  in weight class  $j$  and year  $t$ . I include individual fixed effects and  $\gamma$  represents year fixed effects.  $x'_{it}$  is a matrix of control variables and  $\varepsilon_{ijt}$  is the error term. The coefficient of interest,  $\beta$ , estimates the effect of the number of athletes doping in weight class  $j$  in year  $t-1$  on performance of individual  $i$ , in weight class  $j$  and year  $t$ .

This strategy focuses on changes in the level of doping from year to year. While the overall number of athletes under sanction in a given year may be correlated with performance, I assume athletes modify behaviour according to changes in the competition they face each year. Should the total number of athletes sanctioned go unchanged from year to year, athletes would not be facing a different level of competition or a different probability of being sanctioned. Therefore, the number of athletes beginning a sanction in the prior year is a more relevant variable.

## Results

Results from various regression specifications are provided in the appendix. Table 4 shows the estimates of the variable of interest with controls for age and gender separately, as well as together. All the regressions include controls for weight class, as well as year and individual fixed effects, with robust standard errors. I also report in brackets standard errors clustered by weight class. Unsurprisingly, age, gender and weight class are important determinants of total weight lifted.

The point estimates of the variable of interest are relatively constant regardless of which controls are included, hovering around -0.65 and significant at the 7 percent level (at the 11% level when clustering). The interpretation of this result would be that an additional athlete testing positive in weight class  $j$  in year  $t-1$  decreases total weight lifted (performance) of an individual  $i$  in weight class  $j$  competing in year  $t$  by 0.65kg. Weightlifting competitions operate in increments of one kilogram, and athletes attempting world records select attempts based on 0.5kg increments. It is not uncommon for the top placings in a weight class to be determined by a margin of a single kilogram.

This result could manifest through two channels. First, athletes tend to perform at a higher level when faced with greater competition. This would be contrary to the findings of Brown (2011), who showed that higher competition lead to worsened performances. Athletes do not seem to react with better performances due to a potentially higher chance of placing in their respective classes. Second, actively competing athletes may reduce drug use in observation of their peers receiving sanctions, whether out of fear for being caught or if they feel the same level of drug use is not necessary for this new field of competition.

As a robustness check, in Table 5 I report estimates where the dependent variable is the natural logarithm of total weight lifted. The estimates are negative and significant at the 3% level (6% when clustering). The results indicate that for each additional athlete sanctioned for a doping violation, performance declines by approximately 3%. Broad variation in total weight lifted amongst weight classes and genders makes the interpretation of this estimate slightly obscure. A 3% decline in weight lifted by a male heavyweight is massive in absolute terms compared to the same 3% decline in performance of a lightweight female. I make note of this because

changes in performance of the smallest margin are equally important in determining ranking in any weight class, regardless of the percentage of total weight lifted that the change may represent.

Smith (2013), in his study of the Scripps National Spelling Bee, provide evidence that males and females react differently under pressure. Table 6 reports regression results for males and females separately. While the point estimates vary slightly from the model which includes both genders, the results are consistent. The estimate in the female regression is -0.759 and for males -0.592, however neither of the estimates are statistically significant. Naturally, restricting the sample to a single gender reduces the sample size and the precision of the estimates.

Interestingly, the age of athletes who have tested positive is lower than the age of the rest of the field of competition. The mean age of athletes upon receiving a sanction is 23.74, while the mean age of the remaining field is 24.46. Table 7 reports regression results where the sample is split according to median age. For the younger age grouping, the point estimate of the variable *dopers* increases in magnitude from the original model to -0.97 and is significant at the 6 percent level. On the other hand, the point estimate of the older age grouping is insignificant, although still negative. I thus provide suggestive evidence that younger athletes seem to have a stronger reaction to the level of doping amongst their competitors. This could be due to several factors. Younger athletes may have more control over the rate at which they are able to improve performance.<sup>5</sup> Thus, younger athletes may be able to “step-up” to higher levels of competition via training or drug use, whereas an older athlete may find that their performance

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<sup>5</sup> The more advanced a lifter, the more difficult it is to progress.

is relatively immovable. Amongst the field of non-sanctioned athletes, there may be a higher proportion of younger athletes doping that have not yet been caught, and so more athletes in the younger age group have the option of decreasing consumption of performance-enhancing drugs in response to a higher threat of sanction.

## **Conclusion**

Performance enhancing drugs provide a significant advantage to athletes in the sport of weightlifting, as evidenced by the record number of doping cases in the sport. Sanctions can significantly alter an athlete's career length and prosperity; however, the penalties are not sufficient to bring a stop to doping at the elite level.

Studies of peer-effects in sports have found conflicting results with respect to how athletes respond to various levels of direct competition. Simple OLS regressions using a dataset comprised of eight years of results from the International Weightlifting Federation world championships and Olympic Games, as well as drug test results from the World Antidoping Database, have revealed that weightlifting athletes tend to perform at a lower level in instances where doping directly affects their competitors. Specifically, each additional competitor testing positive results in a decrease in athletic performance of 0.65kg.

Antidoping efforts significantly impact the competitiveness of the field of athletes by directly removing athletes from competition for a significant period. Moreover, antidoping efforts may impose an additional negative externality on the remaining field by reducing competition, which appears to be an important determinant of an athlete's progress. However, antidoping

efforts may also impose a positive externality on the field by making athletes increasingly wary of using performance-enhancing drugs. Thus, there may be a compounding effect of antidoping, where sanctions remove athletes from competition which reduces drug use of the remaining field.

This finding presents a challenge for the International Weightlifting Federation. Antidoping may be eliminating some of the sports' top athletes from competition, further reducing the performance of the remaining field. Losing top athletes does not contribute positively to the growth of the sport; the IWF may have an incentive to maintain smaller penalties for doping. However, stricter doping penalties that eliminate any incentive for athletes to use performance enhancing drugs, such as lifetime sanctions for the first offense, could eradicate doping levels and in turn eliminate this negative external effect on other athletes.

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**Appendix**

**Table 1: Descriptive Statistics**

	Mean	Std. Dev.	Min	Max
Total	246.7072	114.5788	54	473
Male	.5794585	.4937186	0	1
Age	24.36827	4.331871	16	50
Dope	.1165391	.3209176	0	1
Dopers	2.851296	2.303478	0	12

**Table 2: Descriptive Statistics for Dopers**

	Mean	Std. Dev.	Min	Max
Male	.6294416	.4835684	0	1
Age	23.74555	5.221755	16	50

**Table 3: Descriptive Statistics for Non-Dopers**

	Mean	Std. Dev.	Min	Max
Male	.5729514	.4947319	0	1
Age	24.4497	4.196955	16	50

Table 4: Relationship between Performance and Doping of Peers: Main Results

	Total	Total	Total	Total
Dopers	-0.653* (0.366) [0.406]	-0.653* (0.331) [0.375]	-0.654* (0.366) [0.406]	-0.653* (0.361) [0.375]
Age		12.256***		10.401***
Age <sup>2</sup>		-.243***		-.206***
Male			126.224***	125.954***
Weightclass Dummies	✓	✓	✓	✓
Year Dummies	✓	✓	✓	✓
Observations	3002	3002	3002	3002
R-squared	0.8742	0.8789	0.8742	0.8789

Notes: The dependent variable is total weight lifted. Standard errors are shown in square brackets when clustering by weight class.

Table 5: Relationship between Performance and Doping of Peers: Robustness Check

	ln(Total)
Dopers	-.00297** (0.0013) [0.0014]
Age	10.401***
Age <sup>2</sup>	-.206***
Male	125.954***
Weightclass Dummies	✓
Year Dummies	✓
Observations	3002
R-squared	0.8789

Notes: The dependent variable is the natural log of total weight lifted. Standard errors are shown in square brackets when clustering by weight class.

Table 6: Relationship between Performance and Doping of Peers: Results by Gender

	Male	Female
Dopers	-0.592 (0.483) [0.485]	-0.759 (0.698) [0.367]
Age	11.16***	9.909***
Age <sup>2</sup>	-0.215***	-0.202***
Weightclass Dummies	✓	✓
Year Dummies	✓	✓
Observations	1,720	1,282
R-squared	0.7253	0.5219

Notes: The dependent variable is total weight lifted. Standard errors are shown in square brackets when clustering by weight class. Column 1 (2) restricts the sample to male (female) athletes.

Table 7: Relationship between Performance and Doping of Peers: Results by Age

	Age<25	Age>24
Dopers	-.970* (0.516) [0.539]	-.445 (0.490) [0.396]
Age	28.004***	-.037
Age <sup>2</sup>	-.616***	-.032
Male	122.63***	129.216***
Weightclass Dummies	✓	✓
Year Dummies	✓	✓
Observations	1,619	1,383
R-squared	0.8628	0.8969

Notes: The dependent variable is total weight lifted. Standard errors are shown in square brackets when clustering by weight class. Column 1 (2) restricts the sample to younger (older) athletes.