Anti-doping procedures in the United States

A study of tests conducted and sanctions imposed, 2007-2017

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Two-fold purpose of study

- **Substantive**: To analyze tests conducted and corresponding sanctions imposed across a 10-year period.

- **Methodological**: To analyze whether zero-inflated regression models prove useful in examining associations.

Data and quantitative patterns

- Data gathered from 10 Annual Reports of USADA, 2007-2017.
- Broad view of data
  - Athletes competing in **52 sports** across **10 time periods**.
  - Thus **520** instances in which one or more sanctions might be assigned.
- Sanctions assigned
  - **No sanctions assigned** in **422 (81.2%)** of **520** instances.
  - **1 sanction** in **52 (10%)** instances.
  - **2-3 sanctions** in **23 (4.4%)** instances.
  - **4 or more** sanctions in **23 (4.4%)** instances.
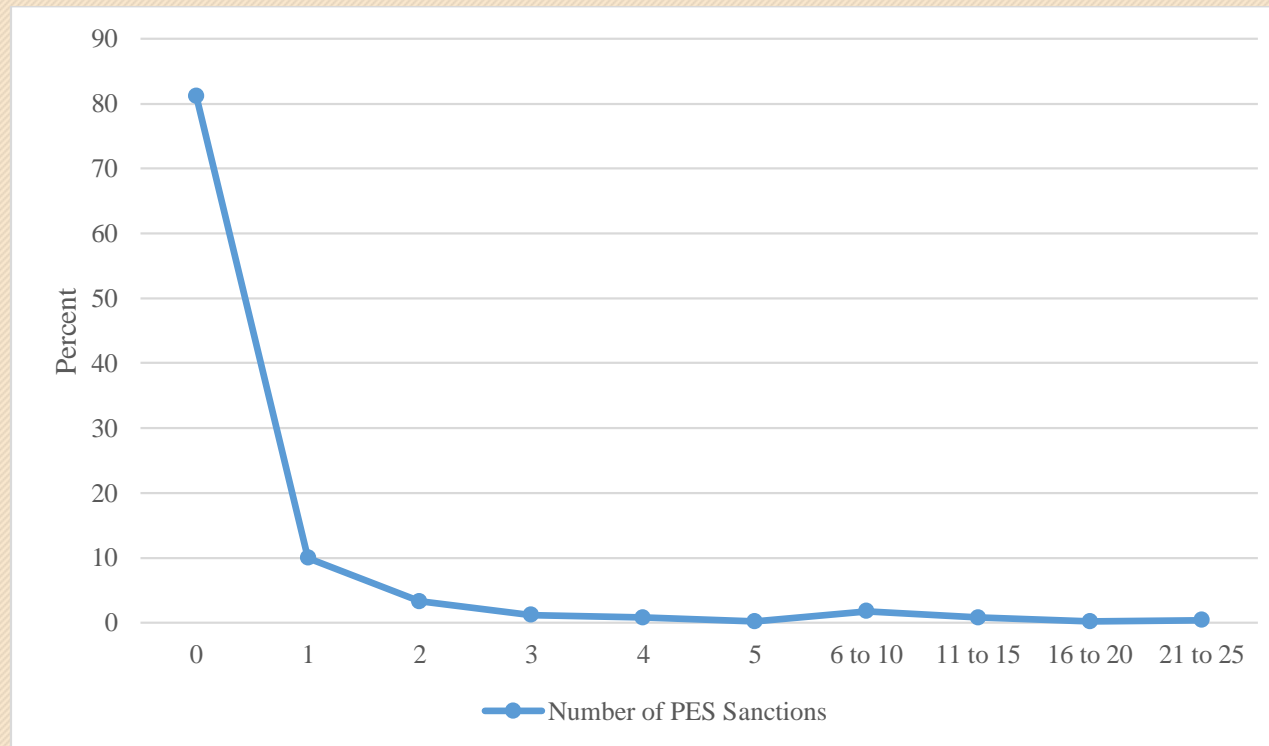
Sanctions visual

Figure 1. Percentages of sanctions imposed in 52 sports in each of 10 time periods

Sanctions assigned

- Total number of sanctions assigned = 331
- Total number of sanctions assigned per sport
  - Three sports account for more than 70% of 331 sanctions.
    - Cycling (N = 100)
    - Track and field (N = 92)
    - Weightlifting (N = 48)

Types of sports

- Individual (e.g., boxing, karate)
- Team (e.g., baseball, basketball)
- Both individual and team sport (e.g., badminton, tennis)
- Stand-alone (10 most-tested sports for regression equations)
  - Bobsled and skeleton, cycling, rowing, skiing and snowboarding, speed skating, swimming, track and field, triathlon, weightlifting, wrestling

Quantitative patterns

Table 1. Descriptive statistics for aggregated data

Sport	Tests	Mean	SD	Sanctions	E-score	Sport	Tests	Mean	SD	Sanctions	E-score
Archery$_I$	342	34.20	9.235	1	.002924	Motocross$_I$	98	9.80	12.726	0	.000000
Badminton$_B$	134	13.40	3.806	0	.000000	Pro Boxing$_I$	1,363	136.30	148.771	3	.002201
Baseball$_T$	155	15.50	16.675	1	.006452	Racquetball$_B$	123	12.30	5.618	1	.008130
Basketball$_T$	389	38.90	34.037	2	.005141	Roller Sports$_{SB}$	324	32.40	15.211	2	.006173
Biathlon$_I$	617	61.70	29.575	0	.000000	Rowing$_S$	1,917	191.70	87.942	6	.006757
Bobsled & Skeleton$_S$	1,869	186.90	68.881	5	.002680	Rugby$_T$	1,281	128.10	70.376	1	.000781
Bowling$_I$	148	14.80	7.315	1	.006757	Sailing$_T$	328	32.80	17.485	0	.000000
Boxing$_I$	940	94.00	39.044	5	.005319	Shooting$_I$	819	81.90	46.199	1	.001221
Brazilian Jiu-Jitsu$_I$	60	6.00	6.992	6	.100000	Skiing & Snowboard$_S$	4,330	433.00	124.193	2	.000462
Canoe & Kayak$_B$	786	78.60	32.959	0	.000000	Soccer$_T$	529	52.90	39.982	1	.001890
Climbing$_I$	20	2.00	1.333	0	.000000	Softball$_T$	219	21.90	10.450	0	.000000
Curling$_T$	335	33.50	17.734	0	.000000	Speedskating$_S$	2,955	295.50	78.241	3	.001015
Cycling$_S$	11,842	1184.20	249.974	100	.008440	Squash$_B$	143	14.30	9.452	0	.000000
Dance Sport$_B$	82	8.20	8.470	0	.000000	Swimming$_S$	7,986	798.60	126.569	6	.000751
Diving$_I$	515	51.50	11.607	2	.003883	Synchronized Swim$_T$	199	19.90	10.461	0	.000000
Equestrian$_I$	267	26.70	15.720	1	.003745	Table Tennis$_B$	133	13.30	4.218	0	.000000
Fencing$_I$	370	37.00	12.499	0	.000000	Taekwondo$_I$	650	65.00	10.863	5	.007692
Field Hockey$_T$	366	36.60	13.802	1	.002732	Team Handball$_T$	372	37.20	19.646	3	.008065
Figure Skating$_B$	959	95.90	27.412	0	.000000	Tennis$_B$	366	36.60	28.864	1	.002732
Gymnastics$_I$	1,152	115.20	42.279	1	.000868	Track and Field$_S$	21,771	2177.10	365.582	92	.004226
Ice Hockey$_T$	991	99.10	62.085	3	.003027	Triathlon$_S$	6,364	636.40	215.222	6	.000943
Judo$_I$	1,071	107.10	24.529	5	.004669	Volleyball$_T$	1,174	117.40	32.837	3	.002556
Karate$_I$	183	18.30	5.813	1	.005464	Water Polo$_T$	528	52.80	15.894	1	.001894
Lacrosse$_T$	86	8.60	11.900	0	.000000	Water Skiing$_I$	220	22.00	10.791	0	.000000
Luge$_I$	590	59.00	23.267	1	.001695	Weightlifting$_S$	4,368	436.80	253.982	48	.010990
Modern Pentathlon$_I$	232	23.20	11.253	0	.000000	Wrestling$_S$	2,179	217.90	65.319	10	.004589

Note: Efficiency score (E-score) equals number of sanctions divided by number of tests. Superscript letters denote categories of the sport-type determinant.

I   Individual sport
T   Team sport
B   Both individual and team sport
S   Stand-alone sport

Regression analysis

Table 2. Ordinal logistic regression analysis with sport type as a determinant of sanctions imposed

			Parameter Estimates				
Parameter	Estimate	SE	Wald	DF	Sig	95% Confidence Interval	
						Lower	Upper
Threshold							
Sanctions = 0	-.698	.567	1.516	1		-1.810	.414
Sanctions = 1	.623	.566	1.209	1		-.487	1.732
Sanctions = 2	2.104	.623	11.414	1	***	.883	3.324
Sanctions = 3							
Location							
Individual	-2.607	.606	18.517	1	***	-3.794	-1.419
Team	-2.874	.631	20.736	1	***	-4.111	-1.637
Both	-3.547	.730	23.581	1	***	-4.979	-2.115
Bobsled	-1.348	.850	2.517	1		-3.014	.318
Cycling	3.931	1.052	13.959	1	***	1.869	5.993
Rowing	-.743	.809	.843	1		-2.328	.843
Ski Snowboard	-1.669	.874	3.646	1	#	-3.382	.044
Speed Skating	-1.307	.835	2.448	1		-2.944	.330
Swimming	-1.210	.838	2.086	1		-2.852	.432
Track and Field	3.548	.981	13.084	1	***	1.625	5.470
Triathlon	-875	.815	1.151	1		-2.473	.723
Weightlifting	1.601	.818	3.829	1	#	-.003	3.205
Wrestling							

*** *p* < .001   ** *p* < .01   * *p* < .05   # *p* < .06

Sanctions within sports

- Of sports that assigned five or more sanctions in a single year, 8 were from track and field, 9 were from cycling, and 2 were from weightlifting.

- No other sports in the study assigned more than 3 sanctions in a single year.

- Among the largest outliers, in 2017, USADA assigned 25 sanctions in track and field as well as 21 sanctions in weightlifting. In 2012, 17 cyclists received sanctions, as did 15 cyclists in 2016.

Quantitative testing patterns

- Total number of tests
  - More than 85,000 tests conducted.
- Total number of tests per sport
  - Five sports account for 60% (N = 52,331) of all tests conducted.
    - Track and field (N = 21,771)
    - Cycling (N = 11,842)
    - Swimming (N = 7,986)
    - Triathlon (N = 6,364)
    - Weightlifting (N = 4,368)

Testing efficiency

- E-score = Number of sanctions / Number of tests
- Results for 10 most-tested sports
  - **Weightlifting:** 48 / 4,368   .010990
  - **Cycling:** 100 / 11,842   .008440
  - **Rowing:** 6 / 1,917   .006757
  - **Wrestling:** 10 / 2,179   .004589
  - **Track and field:** 92 / 21,771   .004226
  - **Bobsled:** 5 / 1,869   .002680
  - **Speedskating:** 3 / 2,955   .001015
  - **Triathlon:** 6 / 6,364   .000943
  - **Swimming:** 6 / 7,986   .000751
  - **Ski and snowboard:** 2 / 4,330   .000462

Discussion

- Athletes in 17 (32.7%) of 52 sports received no sanctions across 10 periods of analysis, and sanctions were absent in 422 (81.2%) of 520 total cases.

- Doping sanctions were most frequent in sports requiring endurance (e.g., lengthy cycling competitions) as well as ballistic strength (e.g., 100 meters, maximum clean-and-jerk).

- Little return on swimming, triathlon, skiing and snowboarding.

Questions for consideration

- If the chances of observing positive results increase as tests do the same, how much error can one expect to observe across (a) differing numbers of tests for (b) differing numbers of athletes in (c) differing numbers of sports in (d) differing numbers of nations?

- If one nation emphasizes certain sports that are not played in another (e.g., cricket), do its athletes in secondary sports have an advantage if those secondary sports are the focus elsewhere?

- What does it mean to be fair and efficient?