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Rate of Performance Change in American Female Weightlifters Over Ten Years of Competition

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ABSTRACT

International Journal of Exercise Science 11(6): 290-307, 2018. The purpose of this study was to evaluate the rates of performance change for American female weightlifters over 10 years of competition. Athlete performance results were gathered from the United States Weightlifting open access, results archive, database. Data was delimited to athletes (N ≥ 750) that competed in Youth or Junior Nationals to ensure athletes were <21yrs old at the first recorded competition. Competition results were converted to strength to mass (SM) ratios to control for the effect of bodyweight on performance. Starting with the first competition date, the highest SM for the snatch (SNT), clean and jerk (CJ) and combined total (T), in three month segments for three years, and six month segments over 10 years, were recorded. Observed percentage change in SM and Cohen's *d* effect size (ES) between each 3- and 6-month segment and the first competition (baseline), for the SNT, CJ and T, was determined. Positive change in rate of performance peaked between time segments baseline-6mo and 7mo-12mo for the SNT (+8.7%, SM 0.68±0.19 to 0.74±0.19, ES=0.34), CJ (+7.7%, SM 0.90±0.24 to 0.97±0.24, ES=0.31) and T (+8.2%, SM 1.57±0.41 to 1.71±0.42 ES=0.34). Total performance increase over 10yrs for the SNT was 27.7% (Year 1 SM 0.68±0.18, year 10 SM 1.13±0.24, ES=0.96), the CJ 22.2% (Year 1 SM 0.90±0.23, year 10 SM 1.40±0.30, ES=0.84), and T 25.0% (Year 1 SM 1.56±0.41, year 10 SM 2.53±0.53, ES=0.91). Observed rates in performance change could be useful for weightlifting coaches as a barometer for evaluating training program outcomes over time.

KEY WORDS: Weightlifting, Olympic weightlifting, snatch, clean, jerk, female strength training, female weightlifting, women weightlifting, women strength training, strength and conditioning

INTRODUCTION

The sport of weightlifting consists of two disciplines; the snatch, and the clean and jerk. The snatch entails the athlete pulling the barbell from the floor and receiving it overhead in one continuous movement. The clean and jerk required the athlete to lift (cleans) the barbell to the shoulders in one continuous movement and then from the shoulders drive the bar overhead (jerk). Because of the distance the barbell must travel, how the barbell is pulled, pushed, and caught, the two disciplines of weightlifting are effective measures of lower body power, strength, speed, balance and coordination (6,9,11). With wide spread use of the two disciplines of weightlifting in the physical training of athletes in many different sports (4), the sport of weightlifting is arguably the most effective way to test and train the construct of athleticism.

While men have consistently participated in weightlifting over the past century the popularity of the sport of weightlifting is still in its infancy among female athletes. Participation in weightlifting by female athletes only appreciably increased over the past five years supported by the increase from 96 athletes at US Nationals in 2012 to 230 in 2017 (United States Weightlifting open access results archive). The popularity of CrossFit and the overall increase in female athletes following the implementation of Title IV have also increased the exposure of female athletes to the snatch and clean and jerk. With only a recent influx of females into weightlifting, there is minimal research data on both performance and rates of change in performance in weightlifting for women. Furthermore, the existing studies are typically only cross sectional (5,15,16) or utilize a small sample size (3).

As female weightlifting is becoming more prevalent in the United States, there is a need to understand reasonable performance increases in the two weightlifting disciplines. An understanding of reasonable performance changes would aid in evaluating training program effectiveness, inform coaches and athletes about expected improvements, and possibly identify talented female weightlifters who might be ahead of an expected improvement rate in performance.

The first two to three years of organized training should yield the greatest changes in performance (1,7,10,14). Following the initial years of training, rates of performance increase may compress and become non-significant by the 10th year of training (1) where the "genetic" and "strength ceiling" (1) may become pronounced. While there has been longitudinal (1,7,10) and cross sectional comparisons (2,17) of performance of different athlete classification (by age and year of participation in college) research on male athletes, there is little research directly analyzing the longitudinal performance changes in female athletes (12). Only one study (n=3 girls, average age 13yrs, tracked for 40 months) longitudinally analyzing youth female weightlifting performance (3).

In light of the lack of data for expected improvements of female weightlifting performance; the purpose of this study was to analyze the performance and rate of performance increase of the snatch, clean and jerk, and total (best snatch plus best clean and jerk) in three month intervals over ten years of local, national and international competition results of trained American female weightlifters.

METHODS

Participants

Competition results of the snatch, clean and jerk, and the total (best snatch plus best clean and jerk) for American female weightlifters (N = 700 to 1250) were used in the study. All the competition results were from USA Weightlifting sanctioned local or national meets, in addition to, any international competition results in which a weightlifter in the study may have participated. In order to control for the effect of biological age on training results, the database

was delimited to only include weightlifters that had competed in either Youth Nationals (17yrs old and under) or Junior Nationals (20yrs old and under).

To control for the effect of body mass on the weightlifting results and for comparison across sever different weight classes, competition data was converted to weight lifted divided by body mass for each weightlifter. The ratio of weight lifted to body mass was calculated for the snatch, clean and jerk, and total for each weightlifter. The study was approved by the Institutional Review Board at Oklahoma City University, although as the competition data was in the public domain, no approval was necessarily required and participants were not required to give consent for their competition data to be used in the study.

Protocol

To determine the rates of performance increase in American female weightlifters, the performance results from January 1997 to February 2015 of sanctioned female United States of America Weightlifting athletes were gathered from the open access database from United States Weightlifting (http://www.teamusa.org/USA-Weightlifting). In the first analysis, weightlifting results for each athlete were grouped into three month timeframes for the first three years to detect the changes early in a weightlifter's career. In a second analysis, weightlifting results were grouped into six month timeframes for up to 10 years of competition to analyze long term changes in performance. A three-year period of training was selected to analyze early increases in performance as significant increases within three years of training had been observed in male athletes (1). A 10-year limit was selected for the long term analysis based on a precedence of previous longitudinal research analyzing performance improvements over time (1).

To describe significant changes in performance from timeframe to timeframe, rates of change were recorded as percentage change from each timeframe to timeframe (three or six months depending on the analysis) and as total change from the first competition for both the three year and 10-year analysis. Effect size was also calculated between timeframes (three or six month, depending on the analysis), and between each timeframe and baseline for both the three year and 10-year analysis.

For each weightlifter, the date of the first recorded competition served as the baseline date (first three or six-month timeframe) for all assignment of subsequent competition data to respective timeframes. As a result, the weightlifters in the study could have begun their weightlifting career any time between the delimited years of data in the study (January 1997 to February 2015).

Data was organized, delimited and filtered (using VBA code) in Excel (Microsoft, Inc). In order to ensure data was assigned to the correct timeframe by the VBA command created in Excel, 10 weightlifters' competition data sets were randomly selected to be manually verified, to ensure data was correctly organized. In addition, the data of one of the weightlifters with the most competition data (18 years of competition data) was also checked by hand to ensure data was accurately assigned to the correct timeframes. For each timeframe, if there was more than one competition result for a weightlifter, the highest result was used for the weightlifter for that

timeframe. It was possible that the highest snatch, clean and jerk, and total were not from the same competition date in each timeframe.

Statistical Analysis

The effect size of timeframe to timeframe changes in mean scores and total change from a timeframe to the first timeframe were calculated using Cohen's *d* (ΔM/pooled SD). Using an effect size definition of smallest meaningful change (SMC) (8) in performance, an ES value of 0.3 was used to determine if a change from timeframe to timeframe, or from the current timeframe to the first timeframe, was meaningful. An ES value of 0.3 has been suggested as a SMC in performance surveillance research, albeit in male athletes (1). There is a dearth of performance surveillance studies with female athletes so the 0.3 parameter was adopted as it was the only precedence of SMC in a long term study of athletic performance (1). The current study was also a descriptive study, capturing the percentage of performance change (10) from one timeframe to the next, along with the total percentage change in performance since the first weightlifting competition. Competition scores for the snatch, clean and jerk, and total were analyzed using the weight lifted to body mass mean score of each weightlifter's results per timeframe.

In determining the percentage change between timeframes, a weightlifter's competition results (snatch, clean and jerk, and total) for a particular timeframe were only added to the timeframe's mean score if the weightlifter also had competition results in the previous timeframe, for comparison. For the baseline timeframe comparison, each weightlifters baseline timeframe results were added to the baseline timeframe mean only when a particular timeframe had a competition result, in order to control for missing data. Essentially pairwise deletion was accomplished on missing data before calculating percent change and effect size.

RESULTS

The percentage change and effect size for the snatch, clean and jerk, and total using a timeframe to timeframe comparison for the first 36 months and over 10 years is displayed in Tables 1 and 3. Percentage chance in performance and the effect size for the snatch, clean and jerk, and total comparing each timeframe to the baseline timeframe over 36 months and 10 years is shown in Table 2 and 4, respectively. Baseline data is not included as there must have been a data pairing for each lifter in order to be included in the table, thus tables start at either three months or six corresponding to the three or ten-year analysis, respectively.

The improvement in performance of the snatch, clean and jerk, and total from three-month timeframe to three-month timeframe (Table 1) declined from the first comparison at six months (snatch: 7.9%, clean and jerk: 6.3% and total: 7.1%) to the last at 36 months (snatch: 2.2%, clean and jerk: 1.1% and total: 1.3%). The smallest increase in performance for the snatch occurred from months 30 to 33 (1.1%); the clean and jerk between months 24 to 27 (0.4%) and the total between months 24 to 27 (0.4%). The largest ES occurred at the first comparison at three months (snatch: 0.29, clean and jerk: 0.25 and total: 0.28). The ES did not exceed 0.20 for any subsequent comparison in the snatch, clean and jerk and total after the six-month timeframe. Strength-to-mass ratio increased in the snatch (0.64±0.19 to 0.93±0.23) and the clean and jerk (0.86±0.24 to

1.17±0.28) from the first comparison at three months to the final comparison at 36 months. The strength-to-mass ratio exceeded the 1.0 milestone in the clean and jerk at month 12. The average body mass of the weightlifter, on average, increased 4kg over the course of the 36 months as well.

When comparing the three-month timeframes against the first or baseline measure of performance (Table 2) the ES, at which SMC first occurred, was at month nine (snatch: 0.45, clean and jerk: 0.44 and total: 0.45). The ES reached its pinnacle at month 33 for all three measures (snatch: 0.89, clean and jerk: 0.84, and total: 0.88). The highest total improvement in the snatch was 29.4% measured at 36 months, 25.9% in the clean and jerk and 27.4% in the total both measured at month 33.

The improvement in performance of the snatch, clean and jerk, and total from six-month timeframe to six-month timeframe (Table 3) declined from the first comparison at 12 months (snatch: 8.7%, clean and jerk: 7.7% and total: 8.2%) to the last at 120 months (snatch: 4.1%, clean and jerk: 3.2% and total: 3.6%). The smallest increase, in fact a decrease, in performance for the snatch occurred from months 102 to 108 (-2.1%); and for the clean and jerk (-3.1%), and total (-2.5%) between months 108 to 114 (-3.1%). The largest ES, and the only instance of SMC in the timeframe to timeframe comparison, occurred at the first comparison at six months (snatch: 0.34, clean and jerk: 0.31 and total: 0.34). Strength-to-mass ratio increased in the snatch (0.68±0.19 to 1.18±0.21) and the clean and jerk (0.9±0.24to 1.46±0.26) from the first comparison at six months to the final comparison at 120 months. The snatch exceeded the 1.0 strength to mass milestone at month 60. The average body mass of the weightlifter, on average, increased 10kg over the course of the 120 months as well.

The improvement in performance of the snatch, clean and jerk, and total from six-month timeframe to six-month timeframe (Table 3) declined from the first comparison at 12 months (snatch: 8.7%, clean and jerk: 7.7% and total: 8.2%) to the last at 120 months (snatch: 4.1%, clean and jerk: 3.2% and total: 3.6%). The smallest increase, in fact a decrease, in performance for the snatch occurred from months 102 to 108 (-2.1%); and for the clean and jerk (-3.1%), and total (-2.5%) between months 108 to 114 (-3.1%). The largest ES, and the only instance of SMC in the timeframe to timeframe comparison, occurred at the first comparison at six months (snatch: 0.34, clean and jerk: 0.31 and total: 0.34). Strength-to-mass ratio increased in the snatch (0.68±0.19 to 1.18±0.21) and the clean and jerk (0.9±0.24to 1.46±0.26) from the first comparison at six months to the final comparison at 120 months. The snatch exceeded the 1.0 strength to mass milestone at month 60. The average body mass of the weightlifter, on average, increased 10kg over the course of the 120 months as well.

When comparing the six-month timeframes against the first or baseline measure of performance (Table 4) the ES, at which SMC first occurred, was at the first comparison at month 12 (snatch: 0.33, clean and jerk: 0.30 and total: 0.32). The ES reached its pinnacle at month 102 for all three measures (snatch: 1.07, clean and jerk: 0.99, and total: 1.04). The highest total improvement in the snatch was 31.8% measured at 102 months, 31.8% in the clean and jerk and 30.1% in the total both measured at month 90.

Table 1. Timeframe to timeframe weightlifting competition data (3 month intervals) from month 3 to month 18

		Time (months)					
		3	6	9	12	15	18
Snt							
	N	763	763	452	422	461	364
	S:M	0.64±0.19	0.69±0.18	0.74±0.2	0.77±0.19	0.79±0.18	0.82±0.2
	Wt (kg)	58±18.5	58.9±18.5	59.8±19.1	60±17.3	59.8±16.6	59.5±17.7
	Snt (kg)	37±14.7	40.5±14.7	43.9±15.5	46±15.3	46.9±14.6	48±16.1
	% change (ES)		7.9 (0.29)	6.6 (0.26)	3.9 (0.15)	2.6 (0.11)	2.8 (0.12)
CJ							
	N	763	763	459	428	474	370
	S:M	0.86±0.24	0.91±0.23	0.97±0.24	1.01±0.23	1.02±0.22	1.06±0.26
	Wt (kg)	58.1±18.5	59±18.5	59.9±19.3	60.2±17.5	59.9±16.5	59.5±17.6
	CJ (kg)	49.4±18.6	53.3±18.4	57.1±18.8	59.9±18.1	60.5±17.3	62.1±20.1
	% change (ES)		6.3 (0.25)	5.9 (0.24)	3.8 (0.17)	1.6 (0.07)	3 (0.13)
Tot							
	N	756	756	447	416	456	358
	S:M	1.49±0.42	1.6±0.41	1.7±0.43	1.77±0.41	1.81±0.39	1.87±0.45
	Wt (kg)	58.1±18.6	58.9±18.6	59.8±19.3	60.2±17.6	59.8±16.6	59.6±17.7
	Tot (kg)	85.9±32.9	93.4±32.7	100.5±33.9	105.3±32.8	106.7±31.2	109.7±35.3
	% change (ES)		7.1 (0.28)	6.1 (0.25)	3.8 (0.16)	1.9 (0.09)	3.2 (0.14)

Table 1 (cont). Timeframe to timeframe weightlifting competition data (3 month intervals) from month 21 to 36

		Time (months)					
		21	24	27	30	33	36
Snt							
	N	300	258	301	239	196	185
	S:M	0.83±0.2	0.87±0.22	0.87±0.21	0.9±0.21	0.91±0.22	0.93±0.23
	Wt (kg)	60.2±17.6	62±19.6	62.9±18.9	61.3±18.3	61±17.8	62.2±18.4
	Snt (kg)	49.1±15.5	52.6±16.3	53.8±16.8	54.3±17	54.7±17.2	57±17.7
	% change (ES)	1.4 (0.06)	4.4 (0.18)	0.5 (0.02)	3.4 (0.14)	1.1 (0.05)	2.2 (0.09)
CJ							
	N	300	259	308	241	198	185
	S:M	1.06±0.25	1.1±0.26	1.11±0.25	1.14±0.25	1.15±0.28	1.17±0.28
	Wt (kg)	60.3±17.7	61.9±19.7	62.9±19	61.4±18.2	61±17.9	62.2±18.6
	CJ (kg)	63.1±19.4	66.7±19.9	68.1±19.7	68.5±20.2	69.3±21.2	71.3±21.6
	% change (ES)	0.6 (0.02)	3.5 (0.15)	0.4 (0.02)	2.8 (0.13)	1.5 (0.06)	1.1 (0.04)
Tot							
	N	294	255	300	236	195	183
	S:M	1.88±0.45	1.96±0.46	1.96±0.46	2.03±0.46	2.06±0.5	2.08±0.5
	Wt (kg)	60.4±17.7	62±19.8	62.9±19	61.3±18.3	61±18	62.2±18.6
	Tot (kg)	112±34.6	118.6±35.8	121.1±36.3	122.3±36.7	123.4±38.1	127.5±38.8
	% change (ES)	1 (0.04)	3.7 (0.16)	0.4 (0.02)	3.2 (0.14)	1.4 (0.06)	1.3 (0.05)

Snt = snatch; CJ = clean and jerk; Tot = total of the snatch, and clean and jerk; S:M = strength to mass ratio.

Table 2. Weightlifting competition data (3 month intervals) compared to the first timeframe, up to one and half years (18 months).

		Time (months)					
		3	6	9	12	15	18
Snt							
	N	1248	763	626	698	627	491
	S:M	0.64±0.18	0.69±0.18	0.73±0.19	0.75±0.19	0.78±0.19	0.79±0.2
	S:M Base	0.64±0.18	0.64±0.19	0.63±0.21	0.63±0.22	0.64±0.24	0.62±0.26
	Wt (kg)	57.4±17.7	58.9±18.5	59.4±18.6	59.5±17	59.6±17.6	59.6±17.4
	Wt Base	57.4±17.7	58±18.5	58.2±18.6	57.5±17.1	57±17.7	56.2±17.8
	Snt (kg)	36.4±14.2	40.5±14.7	42.7±15.2	44.1±14.7	45.9±15	47±16
	Snt Base (kg)	36.4±14.2	37±15.1	36.8±16.3	36.3±16.6	36.5±17.7	35±20
	% change from Base (ES)		7.9 (0.29)	12.7 (0.45)†	15.1 (0.56)†	17.5 (0.63)†	21.7 (0.74)†
CJ							
	N	1249	763	623	691	616	493
	S:M	0.85±0.23	0.91±0.23	0.95±0.23	0.98±0.23	1.01±0.23	1.03±0.26
	S:M Base	0.85±0.23	0.86±0.23	0.85±0.26	0.85±0.26	0.86±0.28	0.84±0.32
	Wt (kg)	57.5±17.7	59±18.5	59.4±18.7	59.5±17.1	59.7±17.5	59.7±17.4
	Wt Base	57.5±17.7	58.1±18.5	58.3±18.7	57.4±17.2	57.1±17.7	56.2±17.8
	CJ (kg)	48.6±17.9	53.3±18.4	55.9±18.3	57.5±17.9	59.6±18.2	60.9±20
	CJ Base (kg)	48.6±17.9	49.4±18.8	49±19.6	48.5±20.1	48.5±21.3	46.8±24.5
	% change from Base (ES)		6.3 (0.25)	11.3 (0.44)†	12.9 (0.51)†	15.4 (0.60)†	19 (0.67)†
Tot							
	N	1246	756	618	687	612	486
	S:M	1.48±0.4	1.6±0.41	1.67±0.42	1.72±0.41	1.78±0.42	1.82±0.45
	S:M Base	1.48±0.4	1.49±0.42	1.48±0.46	1.48±0.47	1.49±0.51	1.45±0.58
	Wt (kg)	57.5±17.8	58.9±18.6	59.4±18.7	59.5±17.1	59.6±17.6	59.6±17.6
	Wt Base	57.5±17.8	58.1±18.6	58.3±18.7	57.5±17.2	57±17.8	56.2±17.9
	Tot (kg)	84.8±31.7	93.4±32.7	98.2±33.2	101.1±32	104.9±32.8	107.6±35.4
	Tot Base (kg)	84.8±31.7	85.9±33.6	85.6±35.6	84.4±36.2	84.4±38.6	81.4±44
	% change from Base (ES)		7.1 (0.27)	11.9 (0.45)†	14 (0.54)†	16.4 (0.63)†	20.3 (0.72)†

Snt = snatch; CJ = clean and jerk; Total = total of the snatch, and clean and jerk; S:M = strength to mass ratio; Base = baseline or the 1st timeframe. †Change in Mean scores surpassed the SMC applicable from the first timeframe.

Table 2 (cont). Weightlifting competition data (3 month intervals) compared to the first timeframe, up to three years (36 months).

		Time (months)					
		21	24	27	30	33	36
Snt							
	N	392	416	398	311	273	274
	S:M	0.82±0.21	0.83±0.21	0.86±0.21	0.87±0.22	0.88±0.22	0.9±0.23
	S:M Base	0.63±0.28	0.63±0.29	0.64±0.3	0.63±0.32	0.63±0.34	0.63±0.35
	Wt (kg)	60.7±18.5	61.7±19.2	61.6±18.2	61.2±18.7	61.3±17.9	63.4±19.6
	Wt Base	56.6±18.9	57.2±19.7	57±18.8	55.2±19.7	55.1±19	56.5±20.8
	Snt (kg)	48.9±15.6	50.5±16.4	52±16.7	52.3±17	53.2±17.1	55.6±17.2
	Snt Base (kg)	35.7±20.4	35.8±22.1	36.2±23	34.8±24.5	34.7±25.2	35.8±26.3
	% change from Base (ES)	22.7 (0.75)†	24.6 (0.81)†	25.4 (0.84)†	27.2 (0.86)†	28.9 (0.89)†	29.4 (0.89)†
CJ							
	N	388	414	393	312	270	273
	S:M	1.06±0.25	1.06±0.25	1.09±0.25	1.1±0.26	1.12±0.28	1.13±0.28
	S:M Base	0.85±0.33	0.84±0.34	0.86±0.34	0.85±0.36	0.83±0.4	0.84±0.4
	Wt (kg)	60.8±18.6	61.7±19.3	61.6±18.3	61.4±18.7	61.4±18	63.4±19.8
	Wt Base	56.7±19	57.3±19.8	57±18.9	55.3±19.6	55.2±19	56.5±20.9
	CJ (kg)	63±19.2	64.4±19.8	66±19.7	66.5±20.4	67.8±21.3	70±21
	CJ Base (kg)	47.7±24.5	47.6±26	48.3±26.5	46.6±28.5	46±30.5	47.4±30.9
	% change from Base (ES)	19.7 (0.71)†	21.1 (0.76)†	21.5 (0.79)†	23.1 (0.81)†	25.9 (0.84)†	25.4 (0.83)†
Tot							
	N	385	412	391	310	269	271
	S:M	1.87±0.46	1.89±0.45	1.94±0.45	1.97±0.47	2±0.49	2.02±0.5
	S:M Base	1.47±0.61	1.46±0.63	1.49±0.64	1.48±0.68	1.45±0.73	1.47±0.75
	Wt (kg)	60.8±18.6	61.6±19.3	61.6±18.4	61.3±18.7	61.4±18	63.3±19.7
	Wt Base	56.7±19.1	57.2±19.8	57±18.9	55.2±19.6	55.2±19.1	56.5±20.9
	Tot (kg)	111.5±34.4	114.4±36	117.5±36.1	118.4±36.9	120.7±38	125.2±37.8
	Tot Base (kg)	82.9±44.8	83±47.8	84.1±49.2	81±52.6	80.3±55.6	82.8±56.9
	% change from Base (ES)	21.2 (0.74)†	22.7 (0.79)†	23.2 (0.82)†	25 (0.84)†	27.4 (0.88)†	27.3 (0.87)†

Snt = snatch; CJ = clean and jerk; Total = total of the snatch, and clean and jerk; S:M = strength to mass ratio; Base = baseline or the 1st timeframe. †Change in Mean scores surpassed the SMC applicable from the first timeframe.

Table 3a. Timeframe to timeframe weightlifting competition data (6 month intervals) up to five years.

		Time (months)				
		6	12	18	24	30
Snt						
	N	902	902	663	500	401
	S:M	0.68±0.19	0.74±0.19	0.8±0.2	0.83±0.2	0.87±0.21
	Wt (kg)	58±18.4	59.2±17.7	59.8±17.4	60.9±18	62.5±19.1
	Snt (kg)	39.1±14.8	43.6±15	47.2±15.4	50.2±16.2	53.7±16.8
	% change (ES)		8.7 (0.34) †	6.8 (0.28)	4.5 (0.19)	4.5 (0.19)
CJ						
	N	899	899	660	493	398
	S:M	0.9±0.24	0.97±0.24	1.03±0.24	1.07±0.25	1.11±0.25
	Wt (kg)	57.9±18.4	59.2±17.8	59.8±17.3	61.1±18.1	62.5±19.2
	CJ (kg)	51.7±18.4	56.9±18.4	60.9±19	64.1±19.6	68.2±19.9
	% change (ES)		7.7 (0.31) †	5.7 (0.24)	3.1 (0.14)	4.3 (0.19)
Tot						
	N	897	897	657	493	398
	S:M	1.57±0.41	1.71±0.42	1.82±0.43	1.89±0.45	1.98±0.46
	Wt (kg)	58±18.3	59.2±17.8	59.7±17.4	61±18.1	62.5±19.2
	Tot (kg)	90.3±32.8	100±32.8	107.4±33.9	113.8±35.4	121.4±36.4
	% change (ES)		8.2 (0.34)†	6.0 (0.26)	3.8 (0.17)	4.4 (0.19)

Snt = snatch; CJ = clean and jerk; Tot = total of the snatch, and clean and jerk; S:M = strength to mass ratio. †Change in Mean scores surpassed the SMC applicable from the previous timeframe.

Table 3b. Timeframe to timeframe weightlifting competition data (6 month intervals) from months 36 to 60 (continued from table 3a).

		Time (months)				
		36	42	48	54	60
Snt						
	N	329	274	221	184	133
	S:M	0.9±0.22	0.92±0.24	0.94±0.24	0.95±0.25	1±0.24
	Wt (kg)	62.7±19.4	63.5±18.4	65.4±20.1	66.2±20.8	65.5±20.8
	Snt (kg)	55.1±17	57.4±17.6	59.9±17.4	61.2±17.4	63.8±17.8
	% change (ES)	2.6 (0.11)	2.6 (0.11)	2 (0.08)	1.4 (0.06)	4.6 (0.19)
CJ						
	N	325	272	221	182	134
	S:M	1.14±0.28	1.16±0.28	1.19±0.29	1.19±0.3	1.25±0.29
	Wt (kg)	62.8±19.6	63.6±18.5	65.5±20.3	66.2±20.7	65.5±21
	CJ (kg)	70.1±21	72.3±21	75.8±21.3	76.4±21.1	79.8±22
	% change (ES)	2.5 (0.11)	1.7 (0.07)	2.5 (0.1)	0.2 (0.01)	4.6 (0.2)
Tot						
	N	324	269	219	181	133
	S:M	2.04±0.49	2.08±0.51	2.13±0.53	2.14±0.54	2.25±0.53
	Wt (kg)	62.7±19.5	63.6±18.5	65.4±20.2	66.2±20.7	65.5±20.8
	Tot (kg)	124.9±37.6	129.3±38.2	135.1±38.2	137±38.1	143.3±39.2
	% change (ES)	2.8 (0.12)	2.0 (0.08)	2.2 (0.09)	0.6 (0.03)	4.8 (0.2)

Table 3c. Timeframe to timeframe weightlifting competition data (6 month intervals) from months 66 to 90 (continued from Table 3b).

		Time (months)				
		66	72	78	84	90
Snt						
	N	115	93	87	79	68
	S:M	1.02±0.24	1.04±0.25	1.07±0.24	1.07±0.25	1.09±0.24
	Wt (kg)	66.8±21.8	66.5±20.2	66.3±19.6	68.6±21.1	68.5±23
	Snt (kg)	66±18	67.1±17.3	68.6±16.8	70.9±16.5	71.8±16.6
	% change (ES)	1.9 (0.08)	1.9 (0.08)	2.4 (0.11)	0.8 (0.03)	1.8 (0.08)
CJ						
	N	115	94	85	79	69
	S:M	1.28±0.3	1.3±0.29	1.32±0.3	1.33±0.3	1.37±0.31
	Wt (kg)	66.4±20.6	66.4±20.5	65.8±19.7	68.7±21	68.5±23.3
	CJ (kg)	82.8±21.8	84±21.4	84.4±20.5	88.4±20.4	90.1±22.3
	% change (ES)	2.4 (0.11)	1.5 (0.06)	1.4 (0.06)	1.0 (0.04)	2.5 (0.11)
Tot						
	N	113	93	85	79	67
	S:M	2.29±0.53	2.34±0.54	2.38±0.54	2.40±0.54	2.46±0.54
	Wt (kg)	66.3±20.8	66.5±20.6	65.9±19.7	68.6±21	68.7±23.6
	Tot (kg)	147.8±39.2	150.9±38.4	152.2±36.8	158.6±36.6	162±38.7
	% change (ES)	2.1 (0.09)	1.8 (0.08)	1.8 (0.08)	0.9 (0.04)	2.3 (0.11)

Table 3d. Timeframe to timeframe weightlifting competition data (6 month intervals) from months 96 to 120 (continued from Table 3c).

		Time (months)				
		96	102	108	114	120
Snt						
	N	54	44	39	34	33
	S:M	1.12±0.24	1.17±0.19	1.15±0.2	1.13±0.25	1.18±0.21
	Wt (kg)	69.4±23.4	65.6±17.8	68.6±20.8	70.3±21.7	68.2±19.7
	Snt (kg)	74.5±15.5	75.3±14.8	76.2±14.9	77.2±18.4	77.9±13.5
	% change (ES)	2.5 (0.12)	4.6 (0.25)	-2.1 (-0.12)	-1.5 (-0.07)	4.1 (0.21)
CJ						
	N	54	44	40	34	33
	S:M	1.4±0.29	1.46±0.24	1.45±0.26	1.41±0.31	1.46±0.26
	Wt (kg)	70.5±24.4	67±19.3	68±20.7	70.3±21.8	68.3±19.8
	CJ (kg)	94±19.9	94.9±18.3	95.5±18.5	96.1±23.5	96.2±17.1
	% change (ES)	2.0 (0.09)	4.3 (0.24)	-0.2 (-0.01)	-3.1 (-0.15)	3.2 (0.16)
Tot						
	N	52	43	38	34	33
	S:M	2.53±0.51	2.64±0.43	2.6±0.46	2.54±0.55	2.64±0.47
	Wt (kg)	69.5±23.8	65.7±18	68.4±21.1	70.3±21.8	68.2±19.7
	Tot (kg)	168.5±34.1	169.2±32.6	171.5±33.7	172.9±41.5	173.6±30.4
	% change (ES)	2.9 (0.14)	4.0 (0.22)	-1.4 (-0.08)	-2.5 (-0.12)	3.6 (0.19)

Table 4a. Weightlifting competition data (6 month intervals) compared to the first timeframe, up to 30 months.

		Time (months)				
		6	12	18	24	30
Snt						
	N	1251	900	750	552	469
	S:M	0.68±0.18	0.74±0.19	0.79±0.2	0.83±0.21	0.86±0.21
	S:M Base	0.68±0.18	0.68±0.2	0.67±0.23	0.67±0.26	0.68±0.28
	Wt (kg)	57.8±17.8	59.2±17.7	59.8±17.4	60.9±18.3	61.6±18.5
	Wt Base	57.8±17.8	58±17.8	57.4±17.6	56.9±18.7	56.9±19.1
	Snt (kg)	38.9±14.4	43.5±15	46.8±15.3	49.7±16	52±16.7
	Snt Base (kg)	38.9±14.4	39.1±15.6	38.5±17.5	38.2±19.8	38.2±21.7
	% change from Base					21
	(ES)		8.7 (0.33)†	14.8 (0.54) †	18.6 (0.66) †	(0.72) †
CJ						
	N	1251	897	746	548	467
	S:M	0.9±0.23	0.97±0.24	1.03±0.25	1.06±0.25	1.09±0.25
	S:M Base	0.9±0.23	0.9±0.25	0.9±0.28	0.9±0.3	0.9±0.32
	Wt (kg)	57.8±17.7	59.2±17.9	59.8±17.3	61±18.3	61.6±18.6
	Wt Base	57.8±17.7	57.9±17.9	57.4±17.5	57±18.8	57±19.2
	CJ (kg)	51.4±18.1	56.8±18.3	60.6±18.9	63.6±19.4	66.1±19.8
	CJ Base (kg)	51.4±18.1	51.6±19	51±21.3	50.6±23.4	50.8±25.1
	% change from Base					
	(ES)		7.6 (0.30)†	12.9 (0.50)†	15.5 (0.60) †	17.6 (0.67) †
Tot						
	N	1250	894	743	547	466
	S:M	1.56±0.41	1.71±0.42	1.81±0.44	1.88±0.45	1.94±0.46
	S:M Base	1.56±0.41	1.57±0.45	1.56±0.5	1.56±0.55	1.57±0.59
	Wt (kg)	57.8±17.7	59.2±17.8	59.7±17.4	60.9±18.3	61.6±18.6
	Wt Base	57.8±17.7	57.9±17.9	57.4±17.5	56.9±18.7	56.9±19.2
	Tot (kg)	89.8± 32.1	99.9± 32.8	106.8± 33.8	112.8± 35.1	117.7± 36.3
	Tot Base (kg)	89.8±32.1	90.2±34.2	88.8±38.2	88.3±42.8	88.5±46.5
	% change from Base		8.2		17	
	(ES)		(0.32) †	13.8 (0.53) †	(0.63) †	19.2 (0.70)†

Snt = snatch; CJ = clean and jerk; Total = total of the snatch, and clean and jerk; S:M = strength to mass ratio; Base = baseline or the 1st timeframe. †Change in Mean scores surpassed the SWC applicable from the first timeframe.

Table 4b. Weightlifting competition data (6 month intervals) compared to the first timeframe, from months 36 to 60 (continued from table 4a).

		Time (months)				
		36	42	48	54	60
Snt						
	N	362	317	250	204	156
	S:M	0.88±0.22	0.91±0.24	0.92±0.24	0.94±0.25	0.98±0.24
	S:M Base	0.68±0.31	0.69±0.32	0.68±0.34	0.68±0.36	0.7±0.37
	Wt (kg)	62.4±18.8	63.3±18.3	65.6±20.6	66.4±20.3	65.1±20.2
	Wt Base	56.3±19.8	55.6±19.8	56.9±22.3	56.4±22.7	55.2±22.5
	Snt (kg)	54.1±16.9	56.2±17.2	58.8±17.6	60.7±17.4	62.4±18.1
	Snt Base (kg)	38±23.4	37.9±25.2	38.3±27.1	37.9±28.8	38.7±29.9
	% change from Base (ES)	23.4 (0.77) †	24.4 (0.78) †	26.5 (0.82) †	28.3 (0.86) †	28.9 (0.90)†
CJ						
	N	359	316	248	202	156
	S:M	1.12±0.28	1.15±0.28	1.17±0.3	1.18±0.3	1.24±0.29
	S:M Base	0.89±0.36	0.91±0.37	0.9±0.4	0.89±0.41	0.92±0.44
	Wt (kg)	62.5±19	63.3±18.4	65.7±20.8	66.3±20.2	65.2±20.5
	Wt Base	56.5±19.9	55.7±19.9	57.2±22.5	56.3±22.6	55.3±22.8
	CJ (kg)	68.7±20.8	70.9±20.6	74.6±21.5	76.1±21.1	78.5±22.3
	CJ Base (kg)	50.1±27.9	50±29.4	50.7±32.2	50±33.5	50.8±35.6
	% change from Base (ES)	20.5 (0.71) †	21 (0.74) †	23.5 (0.78) †	24.3 (0.80)†	25.9 (0.86) †
Tot						
	N	358	314	247	201	156
	S:M	2±0.5	2.05±0.51	2.09±0.53	2.12±0.54	2.21±0.53
	S:M Base	1.56±0.67	1.58±0.69	1.57±0.75	1.56±0.78	1.61±0.81
	Wt (kg)	62.5±19	63.3±18.4	65.6±20.6	66.3±20.3	65.1±20.2
	Wt Base	56.3±19.9	55.7±20	56.9±22.4	56.3±22.6	55.2±22.5
	Tot (kg)	122.5± 37.3	126.8± 37.4	132.9± 38.8	136.4± 38.1	140.5± 39.9
	Tot Base (kg)	87.6±51.2	87.4±54.4	88.3±59.1	87.5±62.1	89±65.3
	% change from Base (ES)	22 (0.75) †	22.7 (0.77) †	25 (0.80) †	26.2 (0.83) †	27.4 (0.89) †

Snt = snatch; CJ = clean and jerk; Total = total of the snatch, and clean and jerk; S:M = strength to mass ratio; Base = baseline or the 1st timeframe. †Change in Mean scores surpassed the SWC applicable from the first timeframe.

Table 4c. Weightlifting competition data (6 month intervals) compared to the first timeframe from months 66 to 90 (continued from 4b).

		Time (months)				
		66	72	78	84	90
Snt						
	N	145	112	101	92	78
	S:M	0.99±0.25	1.01±0.25	1.04±0.25	1.07±0.25	1.07±0.24
	S:M Base	0.7±0.38	0.71±0.39	0.73±0.4	0.74±0.41	0.74±0.41
	Wt (kg)	66.6±20.4	65.8±19.6	66.8±19.7	67.6±21.1	69±22.9
	Wt Base	56±23.1	54.7±22.5	53.9±23.6	55.6±24.3	57.1±25.9
	Snt (kg)	63.9±17.8	64.8±17.5	67.5±17.9	69.5±16.9	70.6±16.3
	Snt Base (kg)	39.3±30.4	39.3±31.1	39.8±33.2	40.9±33.3	41.6±33.4
	% change from Base (ES)	28.9 (0.89) †	29.5 (0.90)†	29.8 (0.94) †	30.8 (0.97) †	31 (0.98) †
CJ						
	N	145	113	99	91	79
	S:M	1.24±0.31	1.27±0.3	1.29±0.3	1.33±0.29	1.34±0.31
	S:M Base	0.92±0.45	0.92±0.46	0.94±0.46	0.96±0.47	0.95±0.5
	Wt (kg)	66.3±19.4	65.7±19.7	66.4±19.7	67.8±21.6	68.9±23.1
	Wt Base	55.8±22.1	54.7±22.6	53.6±23.5	55.8±24.7	57.5±25.8
	CJ (kg)	79.9±21.7	81.1±21.7	83.4±21.4	86.7±20.6	88.7±21.5
	CJ Base (kg)	51.2±36.1	51.1±37.1	51.2±38.8	53.1±39.5	54.4±40.7
	% change from Base (ES)	26.2 (0.84) †	27.1 (0.89) †	27.1 (0.90) †	27.9 (0.94) †	29 (0.94) †
Tot						
	N	143	112	99	91	77
	S:M	2.22±0.55	2.28±0.55	2.33±0.54	2.39±0.54	2.41±0.54
	S:M Base	1.61±0.82	1.63±0.85	1.67±0.86	1.69±0.88	1.68±0.91
	Wt (kg)	66.2±19.6	65.8±19.8	66.4±19.6	67.7±21.6	69.1±23.3
	Wt Base	55.7±22.2	54.8±22.7	53.4±23.6	55.7±24.8	57.4±26.2
	Tot (kg)	142.9± 39	145.7± 39	150.2± 38.7	155.7± 37	159.3± 37.5
	Tot Base (kg)	90± 65.9	90± 68.2	90.3± 71.6	93.7± 72.4	95.6± 74.3
	% change from Base (ES)	27.4 (0.87) †	28.4 (0.90) †	28.4 (0.92) †	29.2 (0.95) †	30.1 (0.97) †

Snt = snatch; CJ = clean and jerk; Total = total of the snatch, and clean and jerk; S:M = strength to mass ratio; Base = baseline or the 1st timeframe. †Change in Mean scores surpassed the SWC applicable from the first timeframe

Table 4d (cont). Weightlifting competition data (6 month intervals) compared to the first timeframe, from months 96 to 120 (continued from 4c).

		Time (months)				
		96	102	108	114	120
Snt						
	N	62	59	49	49	43
	S:M	1.1±0.24	1.12±0.22	1.09±0.25	1.12±0.22	1.13±0.24
	S:M Base	0.76±0.42	0.76±0.42	0.79±0.39	0.79±0.4	0.82±0.4
	Wt (kg)	68.8±22.3	65.8±18.3	69±19.6	67.3±19	69.7±22.6
	Wt Base	57.3±25.2	54±21.8	57.3±22.9	55.5±22.4	58.2±25.4
	Snt (kg)	72.8±15.7	71.9±15.6	72.9±17.2	73.7±17.3	75.3±13.5
	Snt Base (kg)	43.2±33.7	41.7±34.2	45.5±32.6	44.4±34.3	47.3±31.4
	% change from Base (ES)	30.7 (0.98) †	31.8 (1.07) †	27.6 (0.92) †	29.2 (1.01) †	27.7 (0.96) †
CJ						
	N	62	59	50	49	43
	S:M	1.38±0.3	1.4±0.27	1.37±0.31	1.39±0.29	1.4±0.3
	S:M Base	1±0.48	1.02±0.47	1.03±0.46	1.04±0.45	1.09±0.43
	Wt (kg)	69.8±23.2	65.9±18.2	68.5±19.6	67.3±19	69.8±22.7
	Wt Base	58.7±25.8	54.3±21.7	57.1±22.8	55.9±22.3	58.5±25.4
	CJ (kg)	92.1±19.9	89.6±19.6	91.1±21.5	91.3±22.5	93±17.1
	CJ Base (kg)	57.9±39.8	55.4±39.7	59.1±38.9	58.1±40.5	62.4±35.4
	% change from Base (ES)	27.2 (0.94) †	27.2 (0.99) †	24.6 (0.86) †	25.1 (0.92) †	22.2 (0.84) †
Tot						
	N	61	59	48	49	43
	S:M	2.48±0.54	2.51±0.48	2.45±0.55	2.5±0.5	2.53±0.53
	S:M Base	1.76±0.9	1.77±0.89	1.82±0.85	1.82±0.85	1.89±0.83
	Wt (kg)	69±22.4	65.8±18.3	68.8±19.9	67.3±19	69.7±22.6
	Wt Base	57.7±25.2	54.1±21.8	57.1±23.1	55.6±22.4	58.3±25.4
	Tot (kg)	164± 34.7	161± 34.8	163.6± 38.9	164.5± 39.4	168± 30.4
	Tot Base (kg)	100.1± 73.2	96.4±7 3.8	104.3± 71.5	101.7± 74.7	108.8± 67.2
	% change from Base (ES)	28.8 (0.97) †	29.5 (1.04) †	25.9 (0.89) †	27.2 (0.98) †	25 (0.91) †

Snt = snatch; CJ = clean and jerk; Total = total of the snatch, and clean and jerk; S:M = strength to mass ratio; Base = baseline or the 1st timeframe. †Change in Mean scores surpassed the SWC applicable from the first timeframe

DISCUSSION

The purpose of the study was to analyze the rates of performance increase for female American weightlifters over ten years of competition data. While it is generally expected that strength performance will improve in the first three years of a weightlifter's career (1,3), this study actually quantified those percentage changes in three-month and six-month intervals. As expected, the first to second timeframe time point for both the three-month and six-month timeframe interval provided the greatest increase in performance for both the snatch, clean and jerk, and total. Of the three analyzed performance scores (snatch, clean and jerk, and total) the snatch produced the greatest rate of increase (7.9% and 8.7% from timeframe 1 to timeframe 2 for the three year and ten year analyses, respectively). The greater rate of increase in the snatch as compared to the clean and jerk is presumably due to the greater technical demands of the

snatch as compared to the clean and jerk and a possible greater linkage to lower body strength (which is slower to develop) with the clean and jerk as compared to the snatch.

According to the 10-year analysis using six-month interval timeframes, female American weightlifters can expect to see greater gains in the snatch than in the clean and jerk for the first two years of competition (18.6% vs 15.5%, respectively) and effect sizes at the two-year mark were of moderate size (0.6). Baker observed a higher, but similar, effect size at two years of training for male professional rugby players for the bench press (0.7), but in rugby league players from age 16-19 relative bench and squat strength increased at an ES of 1.88 and 1.45 (17). Gains in lower body strength and power in American female weightlifters may be similar to that of upper body strength gains in men of roughly the same age as the women assessed in this study (<21yrs old) (1).

The SM result at two years of training for the total in the current study (1.88±0.45) was also similar to that for youth boys and girls reported by Byrd et al. (SM = 2.0). The average increase in the total, however, was different with Bryd and colleagues recording a 50kg increase in two years while in the current study there was only a 12kg increase. Differences in the observed results between Byrd et al. and the current study could be due to the younger training age and training status of the athletes. In the study by Bryd and colleagues average training age was 13.7±1.2yrs as compared with those in the current study which sampled Youth (under 17yrs old) and Junior (20yrs and under) national level competitors. The average baseline total for athletes in the current study (89.8±32.1kg) was heavier than the athletes in Bryd and colleagues study (71.7±20.2kg), supporting the premise that those athletes in the Bryd et al. study had a lower initial performance, and therefore, had greater potential gains in performance as compared to the athletes in the current study.

The increase in the SNT, CJ and TOT over 10yrs was around 30% with an ES of 1.0 at the highest measure (roughly year 8.5). The ES observed in the current study was less than the 1.26 and 1.74 observed in upper body strength and power for the elite rugby athletes in the study by Baker, but greater than the ES (0.24-.52) for lower body power improvements between senior level and U18 national level female ice hockey players (13). It does appear that at year 8.5 that a "strength celling" may exist for American female weightlifters wherein gains are much more difficult and realized at a slower rate. The collected data shows that percentage of improvement in performance and the effect size plateaued and even declined from year 8.5 to year 10 for the snatch, clean and jerk, and the total.

The premise that gains in muscle size will be necessary to see continual improvements in strength once improvements in neurological function have been optimized (1) seems to be supported in this study. The average body mass of the sample was 57.8±17.7kg for the baseline timeframe and 69.7±22.6kg for the final timeframe at year 10 when using the data for the total. Although weightlifting is a weight class sport, the increase in total body mass with only minor changes in the S:M, especially in the last 1.5 years of competition, would seem to support that gains in muscle size is the primary method to see continual improvements past year three when the percentage increase in performance was declining under 2% between six month intervals.

As the average body mass of the competitors started to rise from year three (62.7±19.5kg) to five (65.5±20.8kg), so did the percentage improvement in performance when using the data analyzing performance changes from six-month timeframe to six-month timeframe (2.8% and 4.8%, respectively) for the total. Of course the assumption would have to be made that any gains in body mass were due primarily to gains in lean mass which may not be the case.

With any database there are certainly limitations to how the data was organized and analyzed, this database is no exception. The database was only with national qualifier American female weightlifters so any inference of the collected data to weightlifters below the national level skill level, international weightlifters or to male weightlifters is limited. As the ages of the athletes was not known, the use of the two age restricted competitions (Youth and Junior Nationals) was done in order to provide a starting point for all the athletes in the study. Inference of the results of this study to athletes that start in the sport of weightlifting after the age of 21yrs of age then will also be limited and should be done with caution. Other factors (family, recovery, access to coaching and equipment) over the years of training in this study certainly can show up as confounding variables that may affect average training frequency, intensity and duration, which would produce changes to competition results.

Missing data was also a challenge as the majority of athletes had at least one timeframe that was empty, although aforementioned pair wise deletion measures were taken to reduce the impact of missing data points on the mean score for each timeframe. The decline in the total sample was also problematic as many athletes participated in weightlifting for a few competitions but did not return to the sport as they aged. There was also the assumption that judging of successful and unsuccessful lifts at local competition was to the same quality as that found at national and international meets, that may not be true for all cases. Because of the large sample size, however, the database used for this study should be robust enough to mitigate any effects that errors in judging (measurement error) may have. Finally, the influence of outside sports and sport seasons are not taken into account in the performance results from United States Weightlifting. As the delimited sample were initially youth or junior athletes, certainly the length and quality of training for each athlete would be different depending on participation in outside sports.

While the rate and amplitude of improvement of performance in the sport of weightlifting is expected to decline as an athlete trains over time, the average rate of improvement is useful for the weightlifting, and even strength and conditioning, coach. By having an appreciation of the general rate of increase every three or six months a coach can better evaluate their program effectiveness much like a doctor would evaluate the general growth of a child using a growth chart. Weightlifting coaches might also use the data from this study for talent identification for successful female American weightlifters. Using the recorded initial competition results, strength to mass ratio, and rate of performance increase, coaches could better identify those athletes with a greater potential for success in the sport of weightlifting. While the data in this study is not useful in identifying athletes that might win national meets, it is useful in identifying athletes that are talented enough to make the qualifying totals for national level events (US Youth and Junior Nationals).

Knowing what are reasonable rates of increase in performance can help better understand the effectiveness of programming and better understand how young athletes improve over time. Specifically, to this study, an appreciation of the average rate for performance increase for female weightlifters can better inform coaches on what are realistic results to expect from a training program and help to identify athletes that are progressing at a faster rate than others. For example, the understanding of when a strength to mass ratio of 1.0 for the snatch typically occurs might help a coach understand if an athlete is ahead or behind in her development. Those athletes progressing faster or starting at a higher level of performance may be those that a coach selects for advanced training, camps and time afforded. Those athletes behind the average rates of performance could be assessed to determine what possible controllable factors are slowing progress. Future research should expand on the idea of identifying rates of performance increase in male weightlifters and in both male and female athletes starting their competition career in weightlifting after the age of twenty.

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