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RESEARCH ARTICLE

ANALYSIS OF THE PERCENTAGE RATIO BETWEEN THE WEIGHT LIFTED IN THE SNATCH AND IN THE CLEAN AND JERK BY INTERNATIONAL ELITE WEIGHTLIFTERS

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Abstract

Olympic weightlifting consists of two lifts, known as the snatch and the clean and jerk. The aim of the present study was to help improve athletic performance by providing information on the optimum ratio between these two lifts. A descriptive, non-experimental method was employed to analyse the percentage ratio between kilograms lifted in the snatch and in the clean and jerk, in 2,994 male (n=1598) and female (n=1396) weightlifters in the senior categories classified among the top 10 in their weight class in the World Championships and Olympic Games between 1998 and 2018. Our results show that this ratio is around 80% and 82% for male and female weightlifters, respectively, with significant differences ($p < .05$) between weight classes but not between medallists in each category. Knowledge of the ratio between the snatch and the clean and jerk will provide coaches with clearer guidance for planning weightlifter training.

Introduction:-

Since 1972, the Olympic sport of weightlifting has consisted of two lifts, known as the snatch and the clean and jerk (Garhammerand Takano, 1992). In the snatch lift, the barbell is lifted from the ground and raised overhead in one continuous movement, whereas in the clean and jerk lift, it is first raised to a racked position at shoulder height and then lifted overhead, in two movements (Garhammerand Takano, 1992). Olympic weightlifting is judged according to the combined total weight (in kilograms) lifted in the best attempt in the snatch and the clean and jerk, which determines each weightlifter's overall result, known as "total" (IWF, 2019).

Regarding the optimum ratio between the snatch and the clean and jerk in order for the athlete to achieve a good balance in performance of the two lifts, weightlifters and coaches often state that there should be a difference of around 20 kg between the two lifts, or more specifically, that the snatch weight should represent 80% of the clean and jerk weight. However, we have found no scientific evidence to support these claims. Only one study, by González-Badillo (1991), has indicated that for an optimum ratio between the two lifts, the snatch weight should represent 78% ± 2% of the clean and jerk weight. However, this study was published more than 29 years ago, and no distinction was made in terms of level, sex or weight class.

As indicated by González-Badillo (1991), knowledge of the percentage value of the snatch weight with respect to the clean and jerk weight would clarify whether one of the lifts presented a poor performance with regard to the

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other and therefore required investigation to determine and rectify the causes, since the regulations establish that it is the combined weight of both lifts that determines each competitor's final result.

Thus, given the importance of this ratio when devising a training programme, the aim of the present study was to conduct a descriptive analysis of the percentage ratio between the snatch and the clean and jerk, discriminating between men and women, weight classes and age categories of the best weightlifters in the world during the period from 1998 to 2018.

Methods:-

Participants:

In line with Veiga et al. (2008), the design used in the present study was observational, descriptive, longitudinal and retrospective. We analysed the results obtained in all Senior World Championships and Olympic Games which maintained the old weight classes. The study therefore encompassed the period from 1998 until November 2018, and the weight classes analysed were as follows:

Men: under 56 kg (<56), under 62 kg (<62), under 69 kg (<69), under 77 kg (<77), under 85 kg (<85), under 94 kg (<94), under 105 kg (<105) and over 105 kg (>105).

Women: under 48 kg (<48), under 53 kg (<53), under 58 kg (<58), under 63 kg (<63), under 69 kg (<69), under 75 kg (<75) and over 75 kg (>75), with the additional weight classes of under 90 kg (<90) and over 90 kg (>90) introduced in 2017 and 2018.

As shown in Table 1, the study population comprised 2994 male (n=1598) and female (n=1396) weightlifters in the senior categories ranked among the top 10 competitors in their weight class in the World Championships and Olympic Games between 1998 and 2018. The study period included 5 Olympic Games and 15 World Championships for the senior category.

Table 1:- Number of weightlifters comprising the study population.

	Men (N= 1598) / Body weight categories.							
Category	<56 kg	<62 kg	<69 kg	<77 kg	<85 kg	<94 kg	<105 kg	>105 kg
Senior	198	200	200	200	180	220	200	200
	Women (N= 1396) / Body weight categories.							
Category	<48 kg	<53 kg	<58 kg	<63 kg	<69 kg	<75 kg	<90 kg	>90 kg
Senior	200	196	200	196	197	199	200	8

Procedures:

Data were collected from records of the results published on the International Weightlifting Federation (IWF) website and accessed on 08/13/2018. The abovementioned competitions were selected in order to analyse the entire period when the old weight classes were used. It should be noted that any case of doping detected after the date the records were accessed would modify the results and data on which this study was based.

Statistical analyses:

All data were analysed using the Statistical Package for Social Sciences (version 24.0, SPSS, Inc., Chicago, IL, USA). The Kolmogorov-Smirnov test was used to corroborate normal distribution in the study sample. Standard statistical methods were used to calculate the mean ± standard deviation (SD), the standard error, and the lower and upper limits of a 95% confidence interval. To estimate the magnitude of the standard deviation according to mean distribution, the coefficient of variation (CV) was calculated. A one-way ANOVA was performed to analyse differences between weight classes (where the factors were weight class and place obtained). When significant differences were detected, the Scheffé post hoc test was conducted to locate them. Statistical significance was set at p=0.05. Effect size (ES) was calculated by means of Cohen's d (ref) and classified as small (0.2-0.3), medium (0.4-0.7) and large (0.8).

Results:-

The Kolmogorov-Smirnov test indicated that all variables presented a normal distribution ($p > 0.05$).Below, the results obtained are reported, divided into the men's and women's senior category.

Men's senior category

Table 2 shows that for the top 10 competitors in this category, the mean value was between 80.72% (<56 weight class) and 83.24% (<105). ANOVA revealed significant differences between weight classes ($p<0.001$), and a Scheffé post hoc test located these differences between the <56 weight class and the <69 ($p= 0.004$; ES = 0.45), <77 ($p= 0.004$; ES = 0.45), <85 ($p<0.001$; ES = 0.69), <94 ($p= 0.01$; ES = 0.40), <105 ($p<0.001$; ES = 0.77) and >105 ($p= 0.04$; ES = 0.36) weight classes; between the <62 weight class and the <85 ($p= 0.023$; ES = 0.90) and <105 ($p= 0.003$; ES = 0.90) weight classes; between the <94 weight class and the <105 ($p=0.05$; ES = 0.90) weight class; and between the <105 weight class and the >105 ($p=0.024$; ES=0.90) weight class.

Table 2:- Percentage ratio between the snatch and the clean and jerk by weight class for the top 10 male competitors in the Senior World Championships and the Olympic Games during the study period (1998-2017).

BWC	N	Mean *	SD	SEM	95% CI		Lowest	Highest	CV
					Lower Bound	Upper Bound			
<56	198	80.72	3.50	0.25	80.23	81.21	69.28	90.71	4.33%
<62	200	81.75	3.34	0.24	81.28	82.21	73.05	92.16	4.09%
<69	200	82.18	3.07	0.22	81.75	82.61	74.85	91.43	3.73%
<77	200	82.19	2.97	0.21	81.78	82.61	75.00	89.74	3.61%
<85	180	83.07	3.36	0.25	82.58	83.57	75.61	94.87	4.05%
<94	220	82.06	3.02	0.20	81.66	82.47	74.09	94.36	3.68%
<105	200	83.24	2.99	0.21	82.82	83.66	72.81	94.12	3.59%
>105	200	81.95	3.35	0.24	81.48	82.42	74.00	90.00	4.09%
Total	1.598	82.13	3.28	0.08	81.97	82.29	69.28	94.87	3.99%

* Mean defines the percentage (%) that snatch represents with regard clean and jerk. BWC = body weight categories. N = sample. SD = standard deviation. SEM= standard error of the mean. CI= confidence interval. CV= coefficient of variation.

In the revision of the top 3 competitors (gold, silver and bronze medallists) in the men's senior category, the mean value was between 82.54% (gold) and 82.95% (silver), as shown in Table 3. ANOVA did not reveal any significant differences with the place obtained ($p=0.441$).

Table 3:- Percentage ratio between the snatch and the clean and jerk for male gold, silver and bronze medallists in the Senior World Championships and the Olympic Games during the study period (1998-2017).

Medallists	N	Mean *	SD	SEM	95% CI		Lowest	Highest	CV
					Lower Bound	Upper Bound			
Gold	160	82.54	3.03	0.24	82.07	83.02	74.40	91.43	3.68%
Silver	160	82.96	2.91	0.23	82.51	83.42	76.61	90.00	3.50%
Bronze	160	82.77	2.89	0.23	82.32	83.22	75.00	89.78	3.49%

* Mean defines the percentage (%) that snatch represents with regard clean and jerk. BWC = body weight categories. N = sample. SD = standard deviation. SEM= standard error of the mean. CI= confidence interval. CV= coefficient of variation.

Women's senior category:

For the top 10 competitors in this category, we found a mean value of between 79.10% (<53 weight class) and 81.51% (<75), as can be seen in Table 4. ANOVA revealed significant differences between weight classes ($p < 0.001$), and a Scheffé post hoc test located these differences between the <48 weight class and the <75 ($p<0.001$; ES = 0.59) weight class; between the <53 weight class and the <63 ($p= 0.03$; ES = 0.38), <69 ($p= 0.03$; ES = 0.41) and <75 ($p<0.001$; ES = 0.65) weight classes; between the <58 weight class and the <63 ($p= 0.03$; ES = 0.38), <69 ($p= 0.03$; ES = 0.41) and <75 ($p<0.001$; ES = 0.90) weight classes; and between the <75 weight class and the <90 ($p<0.001$; ES = 0.46) weight class.

Table 4:- Percentage ratio between the snatch and the clean and jerk by weight class for the top 10 female competitors in the Senior World Championships and the Olympic Games during the study period (1998-2017).

BWC	N	Mean *	SD	SEM	95% CI		Lowest	Highest	CV
					Lower Bound	Upper Bound			

<48	200	79.35	3.66	0.26	78.84	79.86	70.48	88.42	4.61%
<53	196	79.10	3.66	0.26	78.59	79.62	69.77	89.29	4.63%
<58	200	79.14	3.46	0.24	78.66	79.63	68.18	88.50	4.38%
<63	196	80.59	4.07	0.29	80.02	81.16	70.83	92.11	5.05%
<69	197	80.60	3.58	0.26	80.09	81.10	66.67	90.08	4.44%
<75	199	81.51	3.71	0.26	80.99	82.02	70.83	91.30	4.55%
<90	200	79.79	3.75	0.26	79.27	80.31	67.12	90.91	4.70%
>90	8	79.05	2.94	1.04	76.59	81.50	75.16	83.80	3.72%
Total	1.396	80.00	3.78	0.10	79.81	80.20	66.67	92.11	4.73%

* Mean defines the percentage (%) that snatch represents with regard clean and jerk. BWC = body weight categories. N = sample. SD = standard deviation. SEM= standard error of the mean. CI= confidence interval. CV= coefficient of variation.

As regards the mean value for the top 3 female competitors (gold, silver and bronze medallists) in the women's senior category, this was between 78.58% (gold) and 80.30% (silver), as shown in Table 5. ANOVA did not reveal any significant differences with the place obtained (p=0.238).

Table 5:- Percentage ratio between the snatch and the clean and jerk for female gold, silver and bronze medallists in the Senior World Championships and the Olympic Games during the study period (1998-2017). Descriptivestatistics.

Medallists	N	Mean *	SD	SEM	95% CI		Lowest	Highest	CV
					Lower Bound	Upper Bound			
Gold	141	79.58	3.77	0.32	78.96	80.21	67.12	89.29	4.74%
Silver	141	80.30	3.44	0.29	79.73	80.87	73.18	90.20	4.28%
Bronze	141	80.05	3.57	0.30	79.45	80.64	71.43	90.20	4.46%

* Mean defines the percentage (%) that snatch represents with regard clean and jerk. BWC = body weight categories. N = sample. SD = standard deviation. SEM= standard error of the mean. CI= confidence interval. CV= coefficient of variation.

Discussion:-

In Olympic weightlifting, performance is judged according to the combined weight lifted in the snatch and the clean and jerk, and an optimal ratio must be sought between the two in order to improve results. Our study has succeeded in identifying the optimal ratio between performance of these two lifts for elite weightlifters, rectifying the absence of this information and providing an objective basis for correct application of specific training loads in order to work towards particular adaptations in the athlete's neuromuscular system (Stone, Stone, y Sands, 2007).

In all sports, coaches must formulate precise training programmes in order to attain optimum performance, establishing the most efficient training load distribution to maximise the athlete's performance (Bompa, 1994). However, determining the optimum load for each athlete, sport and moment in time has always been the subject of controversy among training specialists, and the correct load to apply in each circumstance has therefore remained unclear (Jiménez-Reyes y González-Badillo, 2011). Although training programmes should be based on solid theoretical foundations, they should also be tailored to the individual athlete, and the results of this study will be of use in customising their characteristics for each athlete (Bompa, 1994; González-Badillo, 1991; Siff y Verkhoshansky, 2004; Szabo, 2013).

It is difficult to compare the results obtained here with those of previous studies, since only two studies were identified that examined the optimum ratio between the snatch and the clean and jerk (González-Badillo, 1991). These established that for an optimum ratio between the snatch and the clean and jerk, the snatch weight should represent 78% of the clean and jerk weight, with an acceptable variation of ± 2%. However, no distinction was made in terms of sex, category, weight class or level of performance.

A comparison of the data obtained in the present study and those reported by González-Badillo (1991) reveals an upward trend in the present research. For example, in the case of men in the senior category, the lowest CI occurred in the <56 weight class for the top 10 competitors (Table 2), ranging between 80.23% and 81.21%.

In the case of women, the widest CIs were observed in the >90 weight class. Thus, for the top 10 competitors and the 3 medallists in the senior category, the CIs ranged between 76.59% and 81.50% and between 70.23% and

87.79%, respectively. When interpreting these results, it is important to bear in mind that only one Senior World Championships have had a >90 weight class (in 2017). Consequently, despite being the world championships for this weight class, the sample analysed only consisted of 8 athletes in the senior category, which thus comprised very small samples compared with all the other weight classes analysed. Meanwhile, the highest CI in the women's senior category was observed in the <75 weight class for the top 10 competitors (Table 4), ranging between 80.99% and 82.02%.

Conclusion:-

Knowledge of the optimum ratio between the performance achieved in the snatch and that attained in the clean and jerk is a useful tool to formulate different training strategies aimed at distributing training load more efficiently in order to improve weightlifting performance.

As indicated by González-Badillo (1991), knowledge of this ratio would clarify whether one of the lifts presented a poor performance with respect to the other and therefore required investigation to determine and rectify the causes, since it is the combined weight of both lifts that determines each competitor's final result. Thus, knowledge of the optimum ratio between the snatch and the clean and jerk for a particular weightlifter profile (taking into account sex, weight class and level) would enable comparison with a given athlete's individual ratio in order to determine what factors/exercises should be given priority in the training programme and strategy.

The present study has shown that for each weight class, category and level, the optimum ratio between performance of the snatch and performance of the clean and jerk in elite weightlifters is close to 80% for women and 82% for men. In this sense, the CI obtained for each category and body weight categories will empower the coaches to accommodate the significant differences that exist, minimizing the errors inherent in the use of statistical averages (Kiely, 2012).

Given the modification of these weight classes approved by the IWF in 2018, it is not possible to transfer the results of our study directly to the new classes; however, the percentage ratio between the snatch and the clean and jerk determined here could be extrapolated depending on the weight of the athlete in question to help coaches optimise their training strategy for weightlifters.

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