

Original Article

Correlation of competitive exercises technique with biomechanical structure of barbell displacement in weightlifting

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Abstract

The study outlines comparative characteristics for biomechanical structure of barbell displacement during the snatch as well as the first stage of the clean and jerk among males and females of elite group that have different body weight in two main phases. These phases of barbell displacement are called as follows: the amplitude of barbell departure in final acceleration phase and the magnitude of its displacement into supporting squat phase, because they characterise economical efficiency of technique, applied in performing competitive exercises.

Purpose of the article is to determine economical efficiency of technique, applied in performing competitive exercises by weightlifters of different genders that have different body weight, with the help of biomechanical structure of barbell displacement. *Material and methods* include analysis of literature, video recording of competitive exercises, biomechanical analysis, as well as mathematical statistics. *Results*. We have determined amplitude value of barbell departure in the phase of final acceleration and the magnitude of barbell displacement into supporting squat with the help of biomechanical structure of barbell displacement by weightlifters of different genders that have different body weight. This allows evaluating economical efficiency of the snatch and clean and jerk technique in the process of improving their sportsmanship. *Conclusions*. Biomechanical structure of barbell displacement in final acceleration phase and supporting squat has some differences depending on competitive exercise, gender of athletes and their belonging to the group of weight categories.

Key words. Weightlifters, weight categories and groups, gender characteristics, competitive exercises, technique, displacement into supporting squat phase.

Introduction

Effectiveness of technique applied in performing competitive exercises in many sports, and in weightlifting in particular, is characterized by its basic criteria: efficiency, sustainability, variability and economical efficiency (Platonov, 2015). Economical efficiency of technique involves rational use of muscular effort, space-time and dynamic characteristics of apparatus movement with minimal energy consumption by the athlete during their exercise completion (Oleshko, 2018).

Some specialists have already studied economical efficiency of competitive exercises technique according to amplitude of barbell departure and the value of its displacement into supporting squat among weightlifters of different sport qualification. For example, Akkus (2012) considers that with increase of athletes' sportsmanship and weights of barbell the depth of squat increases. Other authors (Korkman & Harbili, 2015; Hoover et al., 2006; Campos et al., 2006) have determined that absolute and relative indices of the barbell departure amplitude and squat depth decrease with weight gain. According to Japanese experts (Ikeda et al., 2012; Okada, et al., 2008) the difference between maximum amplitude of barbell departure and the amount of displacement in supporting squat phase should be minimal. At the same time Ho чac et al., (2014) Gourgoulis et al., (2010) believe that the amplitude of barbell movement into supporting squat is influenced not as much as by the level of athlete's physical fitness, but as by their individual characteristics.

Some experts (Campos et al., 2006) developed the values of barbell displacement in supporting squat phase for qualified weightlifters, which averages $0,06 \pm 0,02$ m or 6,0 cm. According to Drechsler (1998), the value of barbell displacement in supporting squat phase among male weightlifting athletes during the snatch comprises 5,0-9,0 % of their body length, and in the first stage of the clean and jerk (lifting of barbell up to chest) is 14-18 % respectively.

We have studied in detail biomechanical structure of barbell displacement in two phases, both during the snatch and the clean and jerk techniques, namely: maximum amplitude of barbell departure in final acceleration phase and then its moving into supporting squat. The difference between these two values indicated economical efficiency of competitive exercise. Moreover, to compare the amplitude of barbell displacement into supporting

squat, performed by weightlifters of different body weight, all biomechanical characteristics were calculated not only in their absolute units (in cm), but also in relative units (in percent of athletes' body length).

Purpose of the article is to determine economical efficiency of technique, applied in performing competitive exercises by weightlifters of different genders that have different body weight, with the help of biomechanical structure of barbell displacement.

Material and methods include analysis of literature, video recording of competitive exercises, biomechanical analysis, as well as mathematical statistics.

Results

With the help of «Weightlifting Analyzer 3.0» software (manufactured in Germany), we have previously fixed and developed model values for barbell displacement into supporting squat phase for qualified weightlifters of different body weight in the process of barbell lifting with maximum weight load (95-100 % of maximum) at national and international competitions (Oleshko, 2014). The results of these studies are presented below (Table 1).

Table 1. Model values of barbell displacement into supporting squat phase by weightlifters of high qualification and different gender, % (men = 85 and women = 62)

Exercise	Athlete's gender	Athlete's body weight		
		"light"	"medium"	"heavy"
snatch	men	9,5-10,0	10,0-10,2	8,1-8,3
	women	10,4-10,8	10,3-10,7	9,6-9,8
clean and jerk (lifting of barbell up to the chest)	men	18,9-19,3	18,3-18,5	19,3-19,7
	women	22,0-22,4	21,4-21,6	20,7-21,1

Note: group 1 ("light") - men with body weight of 56 - 69 kg; women 48 - 58 kg; group 2 ("medium") - men with body weight of 75 - 94 kg; women 63 - 69 kg; group 3 - men with body weight of 105 and + 105 kg; women 75 and + 75 kg respectively.

Also, biomechanical indicators of barbell displacement in a snatch and barbell lifting up to chest have been studied by Russian specialists (Shalmanov et al., 2012), who also recorded biomechanical characteristics in competitive exercises technique, performed by male weight-lifting athletes during competitions (Table 2).

Table 2. Model values of barbell displacement into supporting squat (\bar{x}) performed by qualified weightlifters at 2012 Russian Cup competitions

Indicators	Weight categories, kg							
	56	62	69	77	85	94	105	+105
in snatch								
1	158	155	165	166	165	170	178	184
2	12	14	10	12	6	18	13	20
3	7,6	9,0	6,1	7,2	3,6	10,6	7,3	10,9
in clean and Jerk								
1	158	155	165	166	165	170	178	184
2	42	42	44	47	52	42	49	51
3	26,6	26,6	26,7	28,3	31,5	24,7	27,5	27,7

Note: 1 – athletes' body length (cm); 2 – the difference between maximum height of barbell departure and its displacement into supporting squat, cm; 3 – the amount of barbell displacement (%).

Ukrainian specialist Antoniuk (2012) has also studied economical efficiency of competitive exercise technique by the amount of barbell displacement in the phase of supporting squat performed by female athletes with different body types (dolichomorphic, mesomorphic and brachymorphic) in the jerk (table 3).

Table 3. The amplitude of barbell displacement into supporting squat performed by female athletes of different body type, %

Body type	In snatch	In clean and jerk
Dolichomorphic	9,8-10,2	22,8-23,2
Mesomorphic	9,5-11,1	21,2-22,8
Brachymorphic	8,9-10,2	20,7-23,0

A similar research was also conducted by Mocherniuk (2013), namely studying the snatch and barbell lifting up to chest conducted by weightlifters of different genders and of different body weight, which he analysed while studying videos of international competitions.

The analysis of results gained by the researcher shows that indicators of barbell displacement into supporting squat by weightlifters of different gender in the snatch, which we obtained in many ways coincide with his results. However, in lifting barbell up to chest, the results of author's research have some differences from our data, i.e. they tend to decrease by 3,0 to 7,0 %. These differences can be explained by different methods of recording biomechanical characteristics of weightlifter's competitive exercises technique.

Discussion

Thus, studies of economical efficiency of technique used for the snatch and the clean and jerk by their biomechanical characteristics of barbell displacement show that there are differences among weightlifters of different genders and different body weight in the amplitude of barbell departure in the phase of final acceleration and moving it into the phase of supporting squat. Moreover, these indicators of competitive exercises technique depend on value of load, athlete's gender and body weight, the method of measuring biomechanical characteristics, as well as the length of their body and limbs.

To compare results gained by different specialists and eliminate the differences, we have studied biomechanical characteristics of barbell displacement in the group of elite weightlifters from around the world who, in our opinion, possess a sustainable and economical technique for doing competitive exercises (table 4, 5).

Table 4. The amplitude of barbell displacement during the phase of supporting squat among groups of elite weightlifters in snatch

Athlete	Weight categories, kg	Country	Weight of the barbell, kg	The amplitude of the displacement	
				cm	%
Men					
Tancsics L.	56	Hungary	122	4	2,6
Sezer B.	62	Turkey	136	7	4,3
Su Dayn	77	China	160	7	4,2
Perepetchonov O.	77	Russia	164	5	3,0
Mitrou V.	77	Greece	150	6	3,6
Sagir T.	77	Turkey	167	6	3,6
Lu Xiaojun	77	China	170	8	4,8
Hernandez R.	85	Cuba	157	6	3,5
Sunar E.	85	Turkey	172	6	3,5
Dimas P.	85	Greece	165	5	2,9
Kolecki S.	94	Poland	173	9	5,0
Ilin I.	94	Kazakhstan	175	9	5,1
Bratan A.	105	Moldova	185	8	4,5
Berestov D.	105	Russia	185	8	4,5
Dolega R.	105	Poland	180	9	5,0
Aramnau A.	105	Belarus	201	8	4,6
Kleszcz G.	+105	Poland	185	6	3,3
Cholakov V.	+105	Bulgaria	200	8	4,3
Steiner M.	+105	Germany	200	9	4,9
Scerbatih V.	+105	Latvia	195	9	5,0
Rezazaden H.	+105	Iran	202	9	5,0
Vardanyan A.	+105	Armenia	200	8	4,4
Women					
Pagliaro G.	48	Italy	72	7	4,7
Taylan N.	48	Turkey	85	7	4,5
Dasdelen A.	53	Turkey	88	9	5,6
Muntranu M.	53	Romania	87	9	5,8
Begaj R.	58	Albania	96	8	5,1
Novikava A.	58	Belarus	100	5	3,3
Cocos R.	63	Romania	96	4	2,5
Kirilova G.	63	Bulgaria	100	8	4,9
Tulyeva S.	69	Russia	115	6	3,8
Khurshudyan H.	75	Armenia	117	7	4,1
Valentin L.	75	Spain	115	7	4,1
Korobka O.	+75	Ukraine	117	7	3,8
Kashirina T.	+75	Russia	135	7	4,1
Roditi A.	+75	Greece	105	7	4,1
Usar U.	+75	Turkey	112	7	4,0

Table 5. The amplitude of barbell displacement during the phase of supporting squat among groups of elite weightlifters in clean and jerk

Athletes	Weight categories, kg	Country	Weight of barbell, kg	The magnitude of displacement	
				cm	%
Men					
Dabaya V.	69	Franc	186	15	8,9
Rhachatryan V.	77	Armenia	196	20	11,6
Perepetchonov O.	77	Russia	201	14	8,5
Polovikov V.	85	Russia	205	18	10,5
Dimas P.	85	Greece	205	16	7,9
Kolecki S.	94	Poland	220	19	10,5
Ilin I.	94	Kazakhstan	217	12	6,9
Aramnau A.	105	Belarus	225	20	11,6
Scerbatih V.	+105	Latvia	252	18	9,9
Udachin A.	+105	Ukraine	230	16	8,7
Women					
Dasdelen A.	53	Turkey	122	19	11,9
Kalina Yliya	58	Ukraine	125	19	11,9
Novikava A.	58	Belarus	136	18	11,9
Cocos R.	63	Rumania	130	15	9,3
Kolpakova T.	63	Russia	120	18	11,2
Tulyeva S.	69	Russia	129	18	11,3
Zang Shaoling	69	China	137	19	11,8
Zabolotnaya S.	75	Kazakhstan	141	17	10,4
Podobedova S.	75	Kazakhstan	137	17	10,2
Hromova T.	75	Russia	133	17	10,2
Korobka O.	+75	Ukraine	162	15	8,2
Jan Mi Ram	+75	Korea	178	18	10,5
Khurshudyan H.	+75	Armenia	123	9	5,3
Kashirina T.	+75	Russia	175	17	10,0

Gained data show that the group of elite weightlifters possesses a sustainable and economical technique for doing competitive exercises, because distance of barbell displacement into supporting squat phase is twice less than those of qualified athletes. For example, for group of elite weightlifters (both males and females) the distance of barbell displacement in the snatch comprises on average - 3,4-4,8 %, barbell lifting up to the chest to 8,9-11,8 % respectively.

Conclusions

Thus, the analysis of economical efficiency of competitive exercise technique depending on biomechanical structure of barbell displacement in the phase of supporting squat among weightlifters of different genders and different body weight allows us to draw the following conclusions.

In snatch the amplitude of barbell movement into supporting squat done by weightlifters of different gender of elite group is much smaller than in the clean and jerk. These differences in exercises comprise in average 5,4-7,2 %.

In snatch the value of barbell displacement in the supporting squat for male weightlifters of elite group is almost the same as for female weightlifters, and concerning barbell lifting up to chest it is higher for women by 1,0-3,0 % respectively. Minimal differences between men and women in values of biomechanical structure of barbell displacement in snatch are found among athletes within the second group of weight categories - 0,2 %; and in the clean and jerk among athletes, whose weight is categorised to the third group of weight categories - 0,4 %. For male weightlifters it is found out that with the increase of body weight the value of barbell displacement into supporting squat increases - in average of 23,0 %, for women this tendency was not established. We have determined biomechanical characteristics of the snatch and the clean and jerk for elite group of weightlifters of different gender by amplitude of barbell departure in the phase of final acceleration and the amplitude of barbell movement into supporting squat that need to be guided in the process of improving their sportsmanship.

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Conflict of interest

Authors state no conflict of interest.

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