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Original Article

Dynamics of the snatch technique cinematic parameters in qualified female weightlifters during different periods of training macrocycle

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Abstract:
The requirements to modern sports necessitate the study of the dynamics of snatch technique parameters during different macrocycle periods of qualified female weightlifters training. The purpose of the study is to investigate the dynamics of changes of the snatch informative kinematic parameters in qualified female weightlifters under training conditions during intermediate, preparatory and competitive stages of training macrocycle. It has been found that such kinematic parameters of female weightlifters movements as the maximum lift height (Hmax), the lift height at maximum speed (H at Vmax) and the clean height in squat (Hclean) are undoubtedly changing in qualified female weightlifters of different groups of weight categories during intermediate, preparatory and competitive stages of training macrocycle. The identified changes in the snatch technique kinematic parameters of female weightlifters during different stages of macrocycle training enable it to monitor the technique proficiency level and to verify the appropriateness of the selected means of qualified female weightlifters training for annual major and qualifying competitions.
Key words: weight category, female weightlifter, training phase, space-time parameters, snatch, technique.

Introduction

Female weightlifting as a separate sport has been rapidly gaining popularity both in Ukraine and abroad. The phenomenon is testified by its mass participation as well as the number of qualified female weightlifters in Ukraine, in Europe and in the world (Yussof S., Antoniuk O.V., Poletaev P.A.).

To attain success in any sport it is essential for an athlete to master efficient technique, which is possible only provided that all the athlete's peculiar issues associated with his/her gender, age, qualification, anthropometric data etc. are taken into consideration (Putsov S.O., Oleshko V.G.).

Individual and group biomechanical technique peculiarities of the competitive exercises, which have been mastered at the initial stages of long-term training, are preserved at the subsequent phases of sports perfection. However, deeply ingrained mistakes committed in the process of mastering technique might constantly interfere with maximum individual capabilities implementation at the subsequent stages of sports perfection. Consequently, each phase of female weightlifters long-term training should be accompanied with the technique efficiency level monitoring. The control of the technique informative kinematic parameters should also be exercised within all the period of training macrocycle (Tovstonoh O., Wang X. P.).

Many Ukrainian authors (Antoniuk O., Solodka O., Putsov S., Mocherniuk V.) and foreign scientists (Hiskia G., Xueling Bai, Campos J., Yussof S., Wang X. P., Ulăreanu M. V.) devoted their studies to the snatch and jerk technique analysis. Kinematic parameters of female weightlifters of various qualifications at all stages of long-term training, both under work-out and competitive circumstances have been identified.

Nevertheless, the dynamics of changes in the snatch technique kinematic parameters in qualified female weightlifters belonging to various groups of weight categories during macrocycle periods of training has got insufficient coverage. Information about the dynamics of changes in the snatch technique kinematic parameters during different stages of macrocycle training will allow us to monitor the technique proficiency level and to verify the appropriateness of the selected means of qualified female weightlifters training for qualifying and major competitions of macrocycle.

Research methods

Theoretical analysis and synthesis of scientific methodological and Internet publications on the issue. *Educational observation aided with optical-electronic method of research*. Educational observation involved 21 female weightlifters from three groups of weight classes, who were at the phase of basic and top performance training, qualifying for Candidate Master of Sport of Ukraine and Master of Sport of Ukraine. 189 successful lifts in snatch of 90 % weight from the maximum result of every athlete underwent a precise analysis. The female athletes were divided into groups according to the weight classes: light weight – 48, 53, 58 kg; middle weight – 63, 69, 75 kg; heavy weight

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– 90, over 90 kg. Each group numbered 7 athletes. The snatch technique kinematic parameters were investigated and analyzed by the results of 3 attempts of every athlete during 3different training phases (intermediate, preparatory and competitive) in the conditions of the training process.

Biomechanical video-computer application-specific analysis of female weightlifters' technique efficiency. A motion phase structure approach widely supported by many authors [6, 7, 8, 10] was applied in order to divide the bar motion structure into phases. Besides, the successive movements of an athlete's bodyparts and the bar moves in space were taken into account.

The following informative movement's kinematic parameters were analyzed at each snatch attempt: the maximum lift height (H_{max}), the lift height at the maximum speed (H at V_{max}) and the clean height in squat (H_{clean}).

To obtain video material a special optical electronic device that contained a portable video camera, computer and software was used. To process video footage with weightlifting exercises performance a special original "Coordinate" computer programme was applied (V. Mocherniuk, V. Martyn, Certificate No 1173). This programme allows you to obtain spatio-temporal rhythmic and live parameters of various movements while exercising (Fig.1).

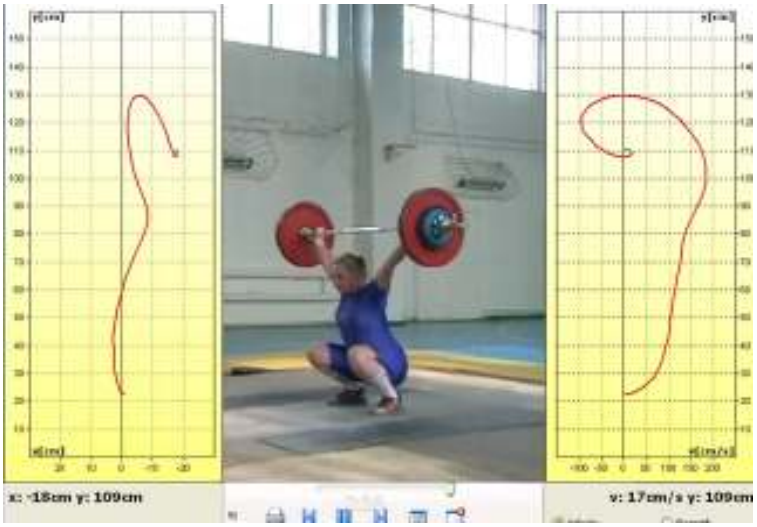

Figure 1. "Coordinate" computer programme

Methods of mathematical statistics: definition of mean arithmetic, quadratic deviation; nonparametric method (sign test, Mann-Whitney) for calculation of differences reliability in homogenous and heterogeneous samples of athletes.

Results

Significant differences could be observed in the parameters of the maximum lift height (H_{max}) in light weight class female athletes during the intermediate (79.9 ± 1.07 %) and preparatory (78.4 ± 5.22 %) phases of training macrocycle. In the intermediate phase this parameter is significantly higher ($p<0.05$) (Table1).

Table 1. Dynamics of snatch technique parameters in the light weight class group female weightlifters 48, 53, 58 kg (n=7)

Training macrocycle periods	Maximum lift height (H_{max}) % height $\overline{X} \pm S$	Lift height at the V_{max} % height $\overline{X} \pm S$	Clean height in squat (H_{clean}) % height $\overline{X} \pm S$
Intermediate	79.9 ± 1.07	62.3 ± 5.86	74.2 ± 2.18
Preparatory	78.4 ± 5.22	58.7 ± 6.67	72.8 ± 1.11
Competitive	80.0 ± 1.53	63.1 ± 8.14	74.5 ± 2.84

Significant difference could also be traced among the parameters of the maximum lift height (H_{max}) in the female weightlifters of the first weight class group during the preparatory and competitive phases ($p<0.05$). No significant differences in the parameters of the aforesaid kinematic parameters during the intermediate and competitive phases of training macrocycle were detected in terms of nonparametric sign test for homogeneous samples ($p>0.05$).

Thus, the maximum lift height parameter (H_{max}) of the light weight class group representatives during the preparatory period of training macrocycle reduced significantly by 1.5 % as compared with the intermediate phase, whereas during the competitive phase this parameter increased again by 1.6 % (Table 1). This tendency peculiar to the maximum lift height exercise denotes the fact that Ukrainian female weightlifters do not use an effective deep squat. Equal phenomenon in the competitive setting was mentioned by other authors (Zhekov I.P., Oleshko V.G.).

The following tendency could be observed in the lift height at maximum speed (H at V_{max}) parameter in the light weight class group athletes: these parameters are significantly higher in the intermediate (62.3 ± 5.86 %) and competitive (63.1 ± 8.14 %) phases of training macrocycle as compared with the preparatory period (58.7 ± 6.67 %).

The clean height in squat (H_{clean}) is dependent upon the maximum bar lift height, as well as on the duration of the 5th snatch phase (fixation phase), which is also confirmed by the research (Mocherniuk V.B.).

Significant differences in the snatch exercise parameters, namely in the clean height in squat (H_{clean}) among the light weight class group representatives were detected in the intermediate (74.2 ± 2.18 %) and competitive (74.5 ± 2.84 %) phases as compared with the similar parameters in the macrocycle preparatory phase (72.8 ± 1.11 %). In the preparatory phase this parameter is significantly lower ($p<0.05$) (Table1).

The same tendency was observed in the two abovementioned parameters in the light weight class group female weightlifters.

Significant differences in the maximum lift height (H_{max}) snatch parameters of the middleweight group weightlifters at different phases of training are somewhat different as compared with the lightweight group representatives (Table 2).

Table 2. Dynamics of snatch technique parameters in the middleweight class group female weightlifters (63, 69, 75 kg) (n=7).

Training macrocycle periods	Maximum lift height (H_{max}) % height $\overline{X} \pm S$	Lift height at the V_{max} % height $\overline{X} \pm S$	Clean height in squat (H_{clean}) % height $\overline{X} \pm S$
Intermediate	81.0 ± 1.98	63.7 ± 3.16	75.0 ± 0.50
Preparatory	80.2 ± 4.59	63.2 ± 9.15	73.6 ± 2.48
Competitive	78.7 ± 2.84	61.0 ± 0.50	73.3 ± 2.22

For this group of female weightlifters parameters displayed during intermediate (81.0 ± 1.98 %) and preparatory (80.2 ± 4.59 %) phases are not significantly different ($p>0.05$). However, the maximum lift height (H_{max}) parameter in the competitive period of training macrocycle is significantly lower (78.7 ± 2.84 %) as compared with the parameters of the intermediate and preparatory phases ($p<0.05$) (Table 2).

This phenomenon testifies to the effect that the athletes during the competitive period far effectively applied deep squat after a bar clean, which the light class female weightlifters failed to perform.

The following parameters of the lift height at maximum speed (H at V_{max}) in the middleweight class athletes could be observed: in the competitive phase this parameter is significantly lower (61.0 ± 0.50 %) in comparison with the same parameters in the intermediate (63.7 ± 3.16 %) and preparatory (63.2 ± 9.15 %) training macrocycle periods. The similar tendency was typical to the middleweight class athletes in the maximum lift height (H_{max}) performance ($p>0.05$). The lift height at maximum speed (H at V_{max}) parameters of middleweight group female weightlifters differ from the same parameters displayed by the representatives of the lightweight class, where the significantly lowest parameter was observed in the preparatory training macrocycle ($p>0.05$).

The significant differences between the clean height in squat (H_{clean}) parameters in the snatch of the middleweight group athletes and the lightweight group female weightlifters during different phases of training are somewhat different (Table 2).

Significant differences were identified among the abovementioned parameter during the preparatory (73.6 ± 2.48 %) and the competitive (73.3 ± 2.22 %) phases as compared to that of the macrocycle intermediate period (75.0 ± 0.50 %). During the intermediate phase this parameter is significantly higher ($p<0.05$) (Table 2). No correlation between maximum lift height (H_{max}) parameters in this weight group was observed.

No significant differences were observed in the parameters of the maximum lift height (H_{max}) in snatch performed by the representatives of the heavyweight class categories during different phases of macrocycle training ($p>0.05$). The parameters recorded in different macrocycle training stages were as follows: (81,8 ± 7,22 %) for the intermediate period; (82,0 ± 6,13 %) for the preparatory phase and (81,3 ± 1,67 %) for the competitive period (Table 3).

Table 3.Dynamics of snatch technique parameters in the heavyweight class group female weightlifters (90, over 90 kg) (n=7).

Training macrocycle periods	Maximum lift height (H_{max}) % height $\overline{X} \pm S$	Lift height at the V_{max} % height $\overline{X} \pm S$	Clean height in squat (H_{clean}) % height $\overline{X} \pm S$
Intermediate	81.8 ± 7.22	62.8 ± 5,38	75.7 ± 0.56
Preparatory	82.0 ± 6.13	63.8 ± 10.86	75.4 ± 2.87
Competitive	81.3 ± 1.67	60.7 ± 1.15	74.1 ± 0.89

However, there were significant differences of the aforesaid parameter in nonparametric (distribution-free) Mann-Whitney test for the heavyweight group female weightlifters in the intermediate, preparatory and competitive phases of the training macrocycle ($p<0.01$). In particular, the maximum lift height (H_{max}) parameter increased with the increase of weight class groups. In other words, the higher weight class, the higher the weightlifter lifts the bar as regards to her stature/height.

Significant difference was also observed in the maximum lift height (H_{max}) parameter during the competitive phase of training among all the weight class groups ($p<0.01$). The lightweight athletes displayed higher parameter (80.0 ± 1.53 % of height) as compared with the middleweight female athletes (78.7 ± 2.84 % of height). The highest parameter, however, was registered in the weightlifters of the third group of weight classes (81.3 ± 1.67 % of height), which could be attributed to larger exertions and less deep squat caused by less flexibility of hip, knee and shoulder joints in 90 and over 90 kg weight class female weightlifters (Table 3).

The registered significant differences in the lift height at maximum speed (H at V_{max}) parameter in the group of heavyweight female athletes were as follows: in the competitive phase it was significantly lower (60.7 ± 1.15 %) as compared with the intermediate (62.8 ± 5.38 %) and the preparatory (63.8 ± 10.36 %) periods of training macrocycle. Similar tendency was observed in this group of weight classes athletes in the bar clean in squat ($p>0.05$). Significant differences were also registered in the lift height at maximum speed (H at V_{max}) parameter by nonparametric Mann-Whitney criterion in the female weightlifters of different weight class groups in the intermediate, preparatory and competitive phases of the training macrocycle ($p<0.01$).

In particular, in the intermediate phase is higher in the middleweight class group of athletes as compared with the light and heavyweight class groups.

The lift height at maximum speed (H at V_{max}) parameter in the preparatory training period is higher in the second and third weight class groups in comparison with the same parameter in the light class group ($p<0.01$). Significant differences were also observed in the lift height at maximum speed (H at V_{max}) parameter in the competitive phase of training. The group of light class weightlifters displayed the highest parameters (63.1 ± 8.14 % of height) among the middleweight (61.0 ± 0.50 % of height) and heavyweight (60.7 ± 1.15 of height) class female athletes. In contrast with the lift height at maximum speed (H at V_{max}) parameter for the heavyweight class categories significant differences were registered in the clean height in squat (H_{clean}) parameters for different phases of training. Similar tendency was traced in the lift height at maximum speed (H at V_{max}) parameter. In particular, significant differences were identified in the preparatory (75.4 ± 2.87 %) and intermediate (75.7 ± 0.56 %) parameters in comparison with those in the competitive (74.1 ± 0.89 %) period of the heavyweight class female weightlifters training macrocycle. In the competitive phase this parameter was significantly higher ($p<0.05$) (Table 3). Different tendencies of the above mentioned parameter were observed in different groups of weight class athletes during different phases of training macrocycle.

Significant differences of the clean height in squat (H_{clean}) were also observed in the clean height in squat (H_{clean}) parameter by nonparametric Mann-Whitney test in the heavyweight lifters of different groups of weight classes during all the three phases of training macrocycle ($p<0.01$). In particular, during the intermediate and preparatory training periods the clean height in squat (H_{clean}) parameter is getting higher along with the weight class rank. Among the heavyweight athletes of different groups of weight classes during the competitive phase the lowest parameter was registered in the female athletes of the middle group of weight classes as compared with those of light and heavy weight classes ($p<0.01$).

Having identified certain tendencies, the authors offered a differentiated programme of technique training for qualified female weightlifters of different groups of weight classes during the intermediate, preparatory and competitive phases of the training macrocycle. The programme contains differentiated means of training (special exercises for the snatch) as well as the instruction guide for their performance.

The athletes are recommended to train according to methodological guides developed by the authors.

It is worthwhile to mention that most snatch exercises as well as the load components were elaborated in compliance with the current programme for children's and youth sports schools. Certain exercises underwent changes and methodological guides were supplemented [4].

You could see below an example of a technique training programme for qualified female weightlifters of the three groups of weight classes during preparatory phase of macrocycle. The authors would like to specify snatch exercises and methodological guides for the light classes group of female weightlifters (Table 4).

Table 4. Snatch technique training programme for female weightlifters of different groups of weight classes during preparatory phase of annual macrocycle

EXERCISES	METHODOLOGICAL GUIDE
Group of light weight classes (48, 53, 58 kg)	
MONDAY	
1. Snatch from the plinths. Above the knees (middle 1/3 of the thigh)	Focus on the squat. Deep squat. Focus on acceleration. Quick top pull.
2. Pull for the snatch from the plinths. Above the knees (middle 1/3 of the thigh)	
TUESDAY	
1. Snatch pulling in squat	Without access to the toes. Squat depth.
WEDNESDAY	
1. Snatch with semisquat from the plinths. Below the knees (upper 1/3 of the shin)	Quick grab. Squat to a 90-degree angle in the knee joint.
FRIDAY	
1. Snatch from the plinths. Below the knees (upper 1/3 of the shin)	Quick squat. Depth of the squat.
SATURDAY	
1. Snatch with semisquat + squatting	Quick grab. Squatting to a 90-degree angle in the knee joint. Quick squat. Depth of the squat.
2. Snatching squat -1	
Group of middle weight classes (63, 69, 75 kg)	
MONDAY	
3. 1. Snatch from the plinths. Above the knees (middle 1/3 of the thigh)	Recovery height, complete straightening.
2. Pull for the snatch from the plinths. Above the knees (lower 1/3 of the thigh)	Recovery height, complete straightening, lift of the shoulders.
TUESDAY	
1. Snatch pulling + squatting	Recovery height. With access to the toes.
WEDNRSDAY	
1. Snatch with semisquat from the plinths. Below the knees (upper 1/3 of the shin)	Recovery height. Quick grab. Squatting to a 100-degree angle in the knee joint.
FRIDAY	
2. Snatch from the plinths. Below the knees (upper 1/3 of the shin)	Recovery height. Quick grab and clean.
SATURDAY	
1. Snatch with semisquat	Recovery height. Quick grab. Squatting to a 100-degree angle in the knee joint.
2. Snatching squat -2	Quick grab. Simultaneous clean and squat.
Group of the heavy weight classes (90, + 90 kg)	
MONDAY	
1. Snatch from the plinths. From the level of the knees	Recovery height, complete straightening, quick grab.
2. Pull for the snatch from the plinths. From the level of the knees	Complete straightening, lifting shoulders, elbows to the side.
TUESDAY	
1.Snatching pull	Recovery height. With access to the toes.
WEDNESDAY	
1. Snatch with semisquat from the plinths. Below the knees (upper1/3 of the shin)	Recovery height. Quick grab. Squatting to a 110-degree angle in the knee joint.
FRIDAY	
1.Snatch from the plinths. Below the knees (upper1/3 of the shin)	Recovery height. Quick grab and clean.
SATURDAY	
1.Snatch with semisquat	Recovery height. Quick grab. Squatting to a 110-degree angle in the knee joint.
2. Snatching squat -2 with semisquat	Quick grab with the hands and bar clean on the prop.

The obtained information about the dynamics of the snatch technique parameters during different phases of macrocycle training of the light, middle and heavy weight groups of weight classes might enhance the efficiency of the selected means and methods of female weightlifters training for major and qualifying competitions of the year, which is the subject of our further research.

Discussion

The outcomes of the research testify to the effect that kinematic characteristics of qualified female weightlifters' movements naturally change depending on weight classes during intermediate, preparatory or competitive phases of training in macrocycle.

The results of the study concerning different kinematic characteristics of movements peculiar to

qualified female weightlifters of different groups of weight classes received their confirmation in the studies of other researchers (Oleshko, 2011, Antoniuk, 2016). In particular, the analysis of the educational observations results suggests that in the intermediate period of training macrocycle there are significant differences (according to distribution-free Mann-Whitney test for heterogeneous samples) in the parameters of the maximum lift height (H_{max}); lifting height at the moment of maximum velocity (H at V_{max}) among the parameters of the group of middle weight classes as compared with the groups of light and heavy weight classes; the clean height in squat (H_{clean}) among the female athletes of all the three groups of weight classes ($p \leq 0,01$). However, the dynamics of the above mentioned characteristics during the annual macrocycle of training was studied and described by the authors for the first time.

The contemporary authors (Putsov, 2008, Oleshko, 2011) suggest that the training programmes for female weightlifters of various weight classes should be differentiated according to the load parameters. Our research, however, indicates the necessity of such differentiation according to the exercises performed at the intermediate, preparatory and competitive periods of macrocycle. The authors propose the programme of the snatch technique training for female weightlifters of different groups of weight classes in the preparatory phase of yearly macrocycle.

Besides, the authors elaborated differentiated methodological guides/instructions for the performing of separate snatch exercises, thus facilitating the effect of these means of training female weightlifters for the major and qualifying competitions of the year. Our further research would be dedicated to experimental validation of the proposed technique training programmes of female weightlifters of different groups of weight classes during various phases of macrocycle according to modern system of athletes training (Platonov, 2015).

Conclusions

1. Analysis of the educational experiment results gives rise to assert that in the group of light weight classes (48, 53, 58 kg) there could be observed a dynamics in all the three parameters, that is in the maximum lift height (H_{max}), the lift height at maximum speed (H at V_{max}) and the clean height in squat (H_{clean}) parameters. The parameters are getting significantly lower (according to nonparametric sign test for homogenous samples) during the preparatory phase as compared to the intermediate one, and later they are getting higher again ($p<0.05$).

Dynamics of the two parameters, namely those of the maximum lift height (H_{max}) and the lift height at maximum speed (H at V_{max}) was registered for the group of middle weight lasses (63, 69, 75 kg). These parameters are getting lower only in the competitive phase. As for the clean height in squat (H_{clean}) parameter, it is getting lower (according to nonparametric sign test for homogenous samples) already in the preparatory phase and so remains in the competitive phase ($p<0.05$).

Dynamics was also noted in the group of heavyweight classes (90, over 90 kg) during different phases of training macrocycle in the lift height at maximum speed (H at V_{max}) and the clean height in squat (H_{clean}) parameters. The parameters are getting lower only during the competitive phase in comparison with the intermediate and preparatory. No significant changes were observed in the dynamics of the maximum lift height (H_{max}) parameter during different phases of training macrocycle ($p>0.05$).

2. Analysis of the educational experiment results allows it to claim that significant differences (according to nonparametric Mann-Whitney criterion for heterogeneous samples) in could be observed during the intermediate phase of heavyweight athletes' training macrocycle in the maximum lift height (H_{max}) parameter; in the lift height at maximum speed (H at V_{max}) parameters characteristic of the middleweight classes in comparison with the groups of light and heavyweight classes; in the clean height in squat (H_{clean}) parameter registered in the heavyweight female athletes of all the three groups of weight classes ($p \leq 0,01$).

Significant differences in the preparatory phase of training macrocycle were observed in the maximum lift height (H_{max}) parameter; in the lift height at maximum speed (H at V_{max}) parameter among the representatives the group of lightweight classes as compared with the groups of middle and heavyweight classes; in the clean height in squat (H_{clean}) among the female weightlifters of all the three groups of weight classes ($p \leq 0,01$).

In the competitive phase of training macrocycle significant changes were registered in the maximum lift height (H_{max}) parameter; in the lift height at maximum speed (H at V_{max}) among the group of light weight classes parameters in comparison with the group of middle and heavy weight classes; in the clean height in squat (H_{clean}) parameter as opposed to the groups of light and heavy weight classes ($p \leq 0.01$).

3. The information about the dynamics of the snatch technique parameters during different phases of macrocycle training of the light, middle and heavyweight groups of weight classes might enhance the efficiency of the selected means and methods of female weightlifters training for major and qualifying competitions of the year, which is the subject of our further research.

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