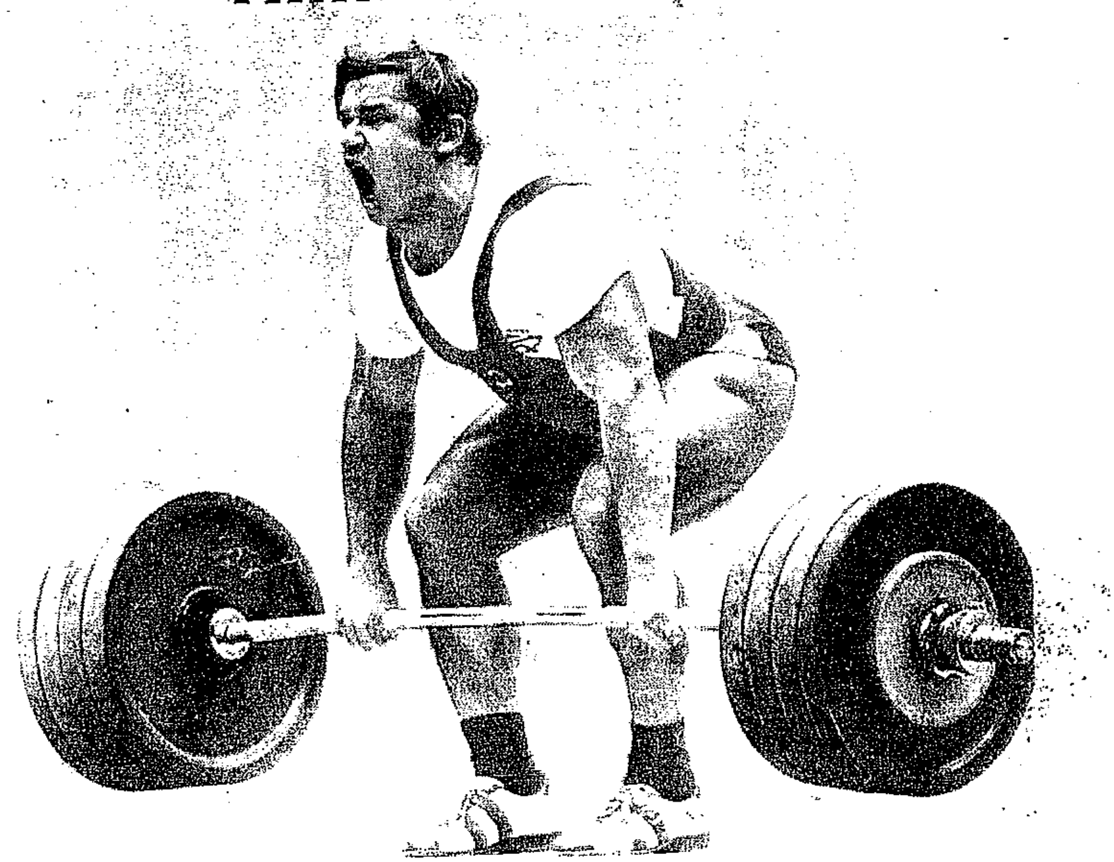
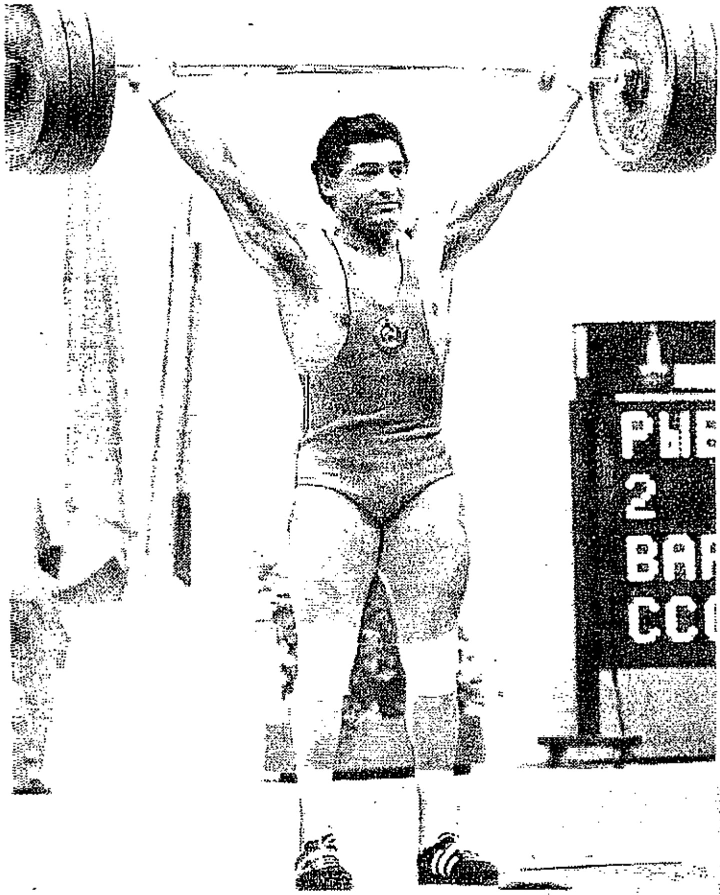
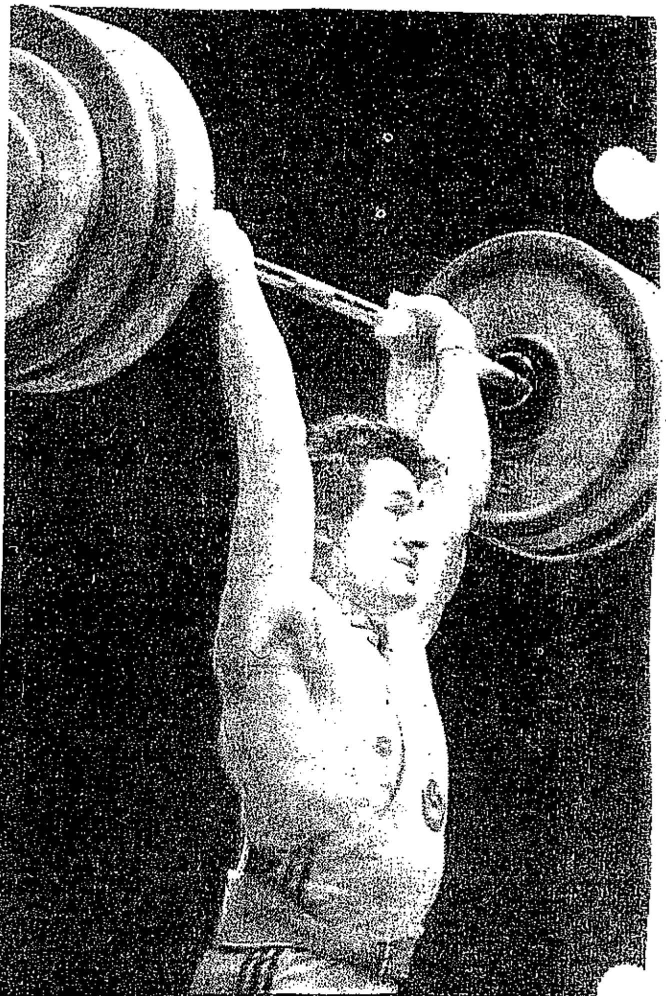
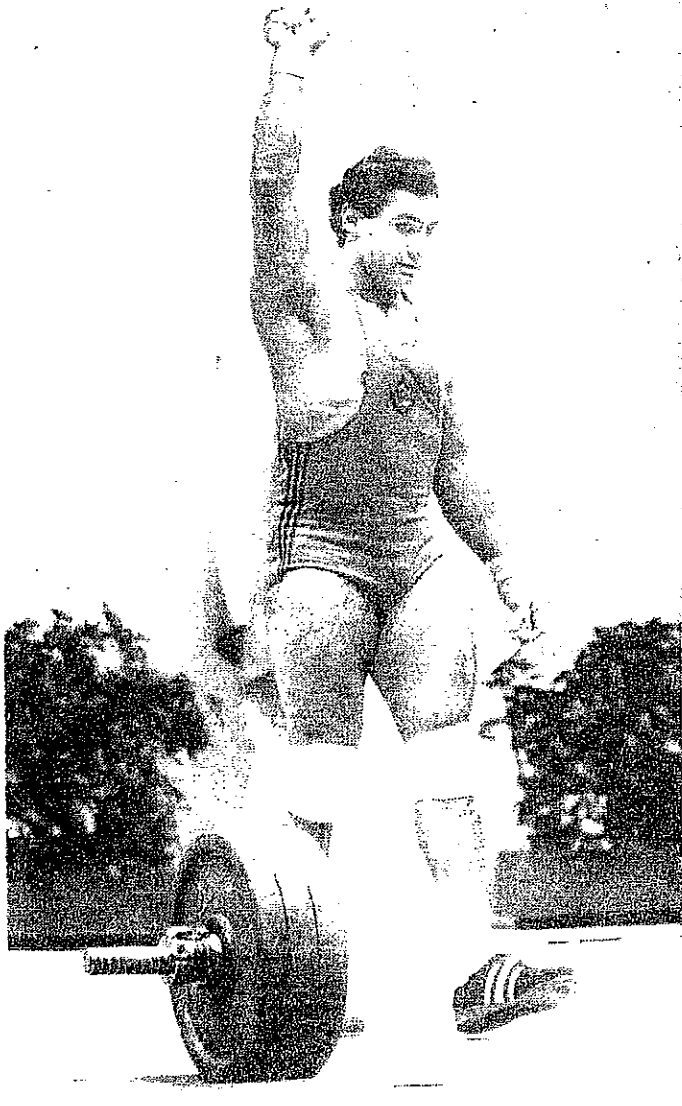
Managing the Training of Weightlifters

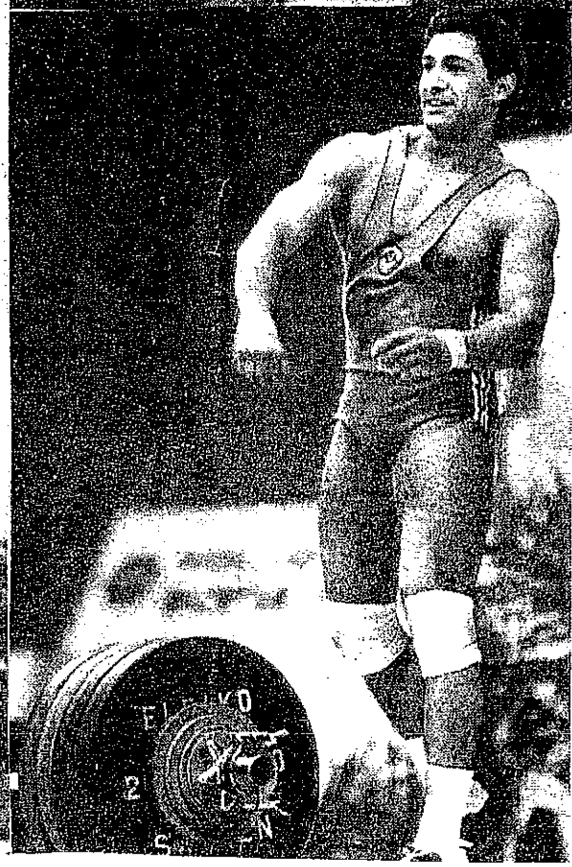
УПРАВЛЕНИЕ ТРЕНИРОВОЧНЫМ ПРОЦЕССОМ ТЯЖЕЛОАТЛЕТОВ











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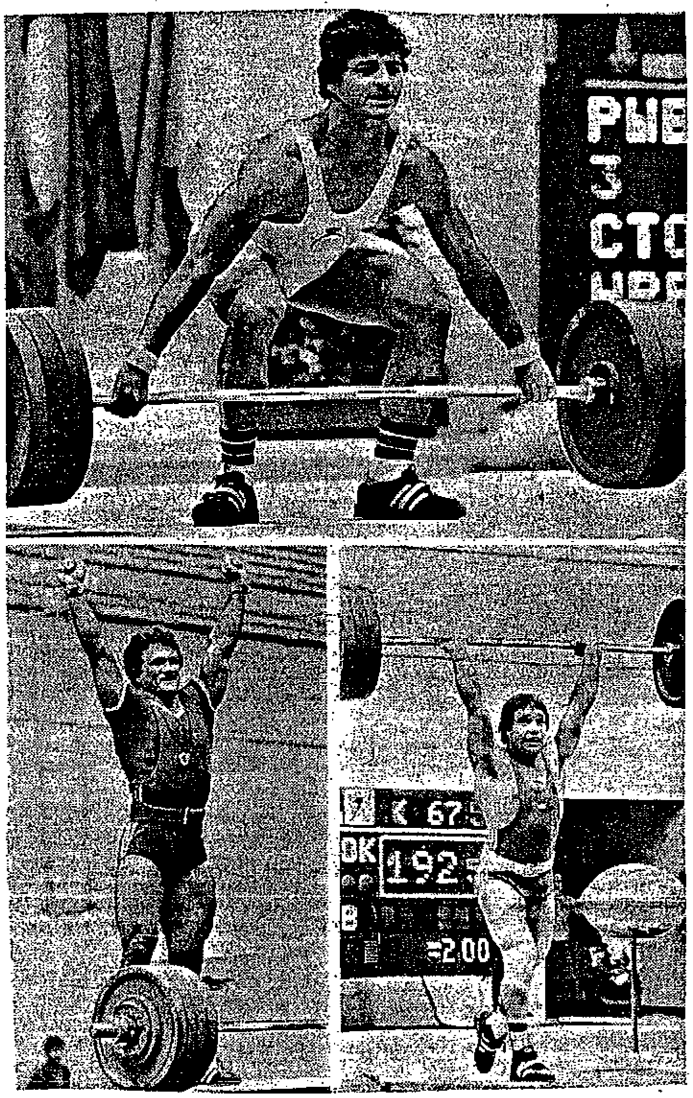


I. Future Records in Weightlifting

According to specialists, one of the important factors governing training is the prognosis of sporting achievements. In order to effectively manage the preparation of sportsmen it is necessary to know what sort of results this or that athlete will make in forthcoming competitions.

World achievements in weightlifting are constantly rising. From this standpoint, it is of interest to reveal which factors are responsible for the increase in sporting results in weightlifting and how long this will continue.

If one examines the dynamics of the records in sports over the last one hundred years a tendency for the records to increase rapidly is noticed in two periods -- after 1872 and 1896. The first leap in records can be explained by the introduction of measurement: before 1872 athletes struggled only for victory, then the rivals became time, distance and weight. The second leap from the year 1896 was due to the revival of the Olympic Games. The regular meeting of the world's strongest athletes at competitions and the recording of the records significantly stimulated the increase in weightlifting achievements.

The biological factor is believed to exert a positive influence on the growth of records in this type of sport. The Earth's population is constantly growing, consequently the number of people engaged in sport also increases which in turn increases the probability that those with the greatest aptitude will go into weightlifting.

It is also impossible to leave out the acceleration factor -- the functions and systems of the young organism grow faster. Since acceleration is temporary it renders a positive influence on the dynamics of sport records.

With the development of the scientific-technical revolution in our country and abroad the physiological, pedagogical and sociological factors conditioning the achievement of record results acquire special significance. The decisive factors are pedagogical which consist of modern methods of managing the training and sporting form of sportsmen, methods of programming training, techniques and tactics of sport struggles and new methods of developing physical qualities. All of these components or each of them individually can be used, in training, as reserves for raising achievements.

Some factors have temporal limitations independent of the year of training. For example, the time factor in training. Athletes, it goes without saying, cannot train more than 24 hours in a day, seven days a week and 365 days a year, but at the present time weightlifters train 8-10 times a week and 2-3 times per day. Is it worthwhile to further increase the frequency and volume of training? You see, the organism needs time for the restoration of depleted resources. Obviously, the future growth of sporting achievements will occur through the qualitative execution of training loads, perfectioning of technique, use of new training influences and the most effective means of recuperation. Included in this group of factors is the creation and perfection of sport inventions, equipment of athletes and sport halls. There are many examples in the history of sport when technique novelties and inventions (the fiberglass pole, the tartan track, specially constructed javelins, improvements in the rowing oar and vessels and so forth) have influenced the dynamics of sport achievements.

So, records are constantly growing and will continue to grow. The theoretical line of the development of sport achievements never ends, only the units of measurement change. In the not too distant future it will be necessary to add several grams to the apparatus in order to establish a world record in one of the exercises. Yet, nevertheless, the limits of man's potential are still difficult to determine.

What will be the weightlifting world records of the future? Some specialists have attempted to prognose the sporting achievements of weightlifters. Thus, in 1977 at the beginning of the four-year Olympic cycle Rumyn L. Baroga, head coach of the national team predicted that the following totals would be necessary for victory at the 1980 Olympics: 52 kg class - 247.5 kg, 56 kg - 267.5, 60 kg - 290 kg, 67.5 kg - 315 kg, 75 kg - 350 kg,

Table 1. Best achievements in Weightlifting for the Period 1972-1980.

Kg		1972	1973	1974	1975	1976	1977	1978	1979	1980
	S	105.0	105.5	106.5	108.0	108.5	109.0	109.5	111.0	113.0
52	J	130.0	140.0	132.5	135.5	141.0	140.0	141.5	142.0	142.5
	T	230.0	240.0	232.5	242.5	242.5	247.5	240.0	242.5	245.0
	S	115.0	117.5	112.5	113.0	120.5	115.5	117.5	121.5	125.5
56	J	142.5	151.0	147.5	145.0	145.0	145.0	147.5	153.0	157.5
	T	250.0	257.5	260.0	255.0	262.5	252.5	260.0	267.5	275.0
	S	120.0	122.5	126.0	130.0	130.0	122.5	125.0	128.0	133.0
60	J	157.5	158.5	157.5	161.0	161.5	165.0	165.5	166.0	167.0
	T	257.5	277.5	280.0	285.0	287.5	280.0	290.0	292.5	297.5
	S	135.0	132.5	130.0	138.5	141.0	142.5	140.0	147.0	148.0
67.5	J	177.5	175.0	175.0	177.5	172.5	175.0	180.5	187.5	195.0
	T	312.5	312.5	305.0	312.5	315.0	315.0	312.5	332.5	342.5
	S	147.5	150.5	152.5	153.0	155.5	157.5	155.0	155.0	161.0
75	J	185.0	190.0	187.5	190.0	193.0	195.5	196.5	190.0	205.5
	T	327.5	337.5	340.0	337.5	345.0	347.5	347.5	345.0	360.0
	S	160.0	161.5	163.5	165.5	170.0	157.5	171.5	176.0	177.5
82.5	J	201.0	201.5	202.5	203.5	207.5	205.0	210.5	215.0	222.5
	T	355.0	357.5	362.5	365.0	372.5	362.5	377.5	390.0	400.0
	S	167.5	170.0	178.0	177.5	180.0	167.5	180.5	175.0	175.0
90	J	207.5	213.5	215.5	220.0	221.0	212.5	221.5	222.5	223.0
	T	352.5	380.0	392.5	395.0	400.0	375.0	397.5	390.0	392.5
	S				170.0	177.5	176.5	178.5	180.0	183.5
100	J	Intro. in 1976			207.5	227.5	221.0	223.0	230.0	230.5
	T				370.0	380.0	387.5	395.0	402.5	405.0
	S	175.5	177.5	170.0	180.0	185.0	180.0	182.5	186.0	190.5
110	J	222.5	224.0	227.5	237.5	230.0	225.0	230.0	238.0	240.0
	T	380.0	400.0	390.0	417.5	415.0	405.0	410.0	412.5	422.5
Ov.	S	175.5	183.5	187.5	198.0	200.0	195.5	200.5	192.5	195.0
110	J	230.0	240.0	243.5	247.5	255.0	256.0	242.5	250.0	245.0
	T	405.0	417.5	427.5	432.5	442.5	445.0	430.0	435.0	440.0

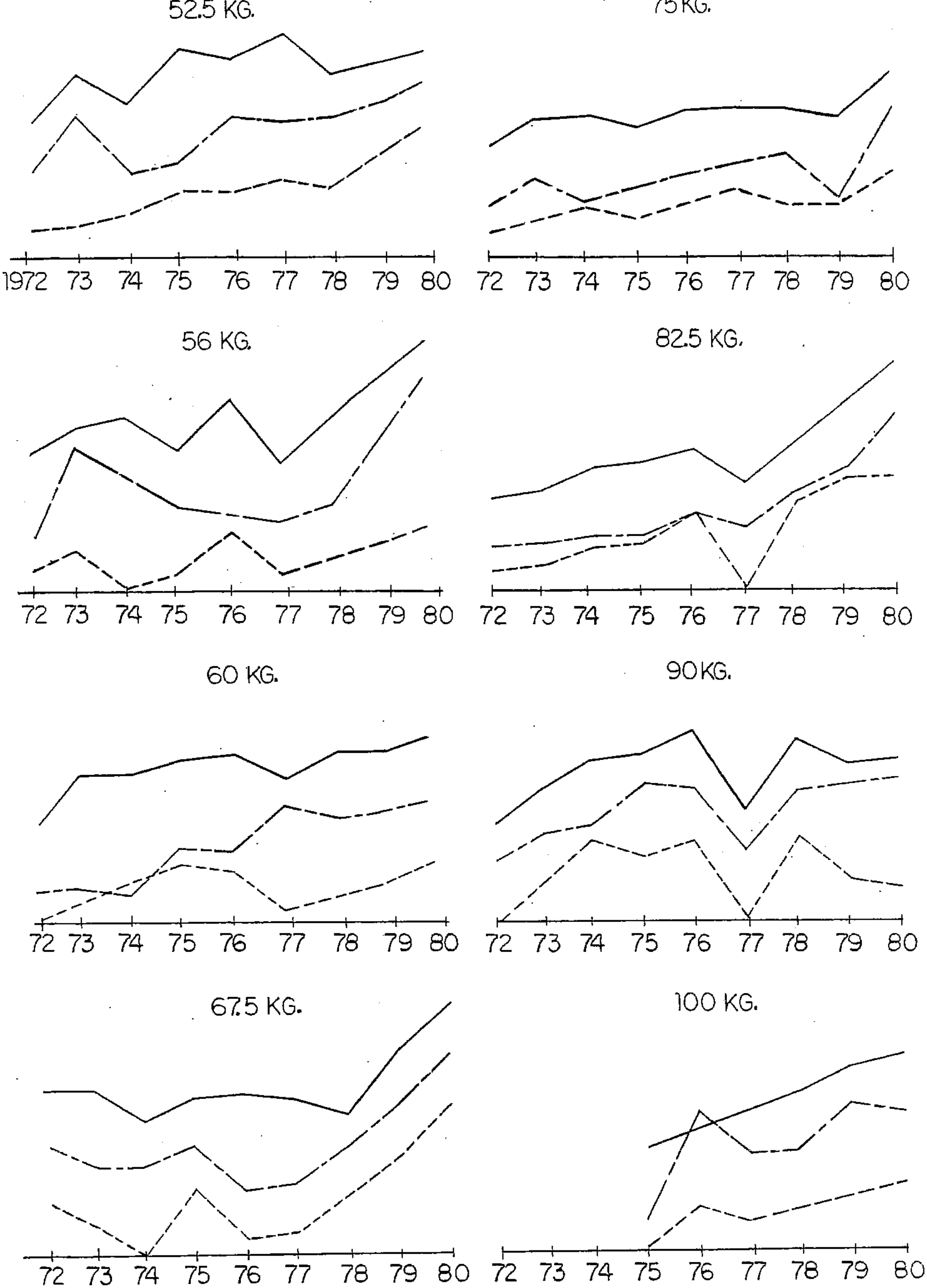
Abbreviations: S- snatch; J- clean and jerk; T- total.

82.5 kg - 375 kg, 90 kg - 395 kg, 100 kg - 405 kg, 110 kg - 410 kg, over 110 kg - 450 kg.

The winning totals at the Moscow Olympics were: 52 kg - 245 kg (K. Osmonaliev, USSR), 56 kg - 275 kg (D. Nunez, Cuba), 60 kg - 290 (V. Mazin, USSR), 67.5 kg - 342.5 kg (Y. Rusev, Bulgaria), 75 kg - 360 kg (A. Zlatev, Bulgaria), 82.5 kg - 400 kg (Y. Vardanyan, USSR), 90 kg - 377.5 (P. Baszako, Hungary), 100 kg - 395 kg (O. Zaremba, Czechoslovakia), 110 kg - 422.5 kg (L. Taranenko, USSR), over 110 kg - 440 kg (S. Rakhmanov, USSR). By comparing L. Baroga's prognosis with the factual results of the 1980 Olympics we see that one prognosis was absolutely correct (60 kg - 290 kg), in one (52 kg) the error was a minimal 2.5 kg (247.5 and 245 kg); the difference was 7.5 kg (267.5 and 275 kg) in one weight class (56 kg); the difference was 10 kg in three (75, 100 and over 110 kg); larger in one case (350 and 360 kg) and lower in two (405 and 395 kg; 450 and 440 kg). The result exceeded the prognosed by 12.5 kg (410 and 422.5 kg) in one class (110 kg). The factual results in the 90 kg class was 17.5 kg less than the prgnosis. Here, in our view, the reason was the favorite, D. Rigert's "bomb out" in the snatch. The factual results in two weight classes (67.5 and 82.5 kg) greatly exceeded the prognosis (27.5 and 25 kg respectively) because of Y. Rusev and Y. Vardanyan's phenomenal world records. Vardanyan's 400 kg total exceeded the winning totals in the next two heavier weight classes.

We attempted to predict the best totals in 1984. We analyzed the best results in the snatch, the clean and jerk and the total from 1972 to 1980 (table 1). It helps to graphically depict the changes in the snatch, the clean and jerk and the biathlon total (figures 1-10) over the aforementioned period (1972-1980).

A general regularity can be observed for all the weight classes. The records in the majority of the weight classes increased gradually and reached maximum in 1976 (the Olympic year). There was an insignificant decrease in 1977 (which corresponds to the modern conceptions about the direction of the macrocycle in the long term preparation of weightlifters). There was a noticeable tendency for results to gradually increase and in 1980, an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75 KG.
72 73 74 75 76 77 78 79 80
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100 KG.
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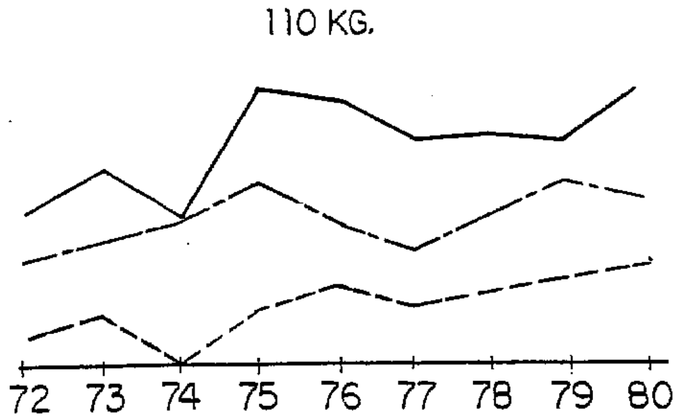
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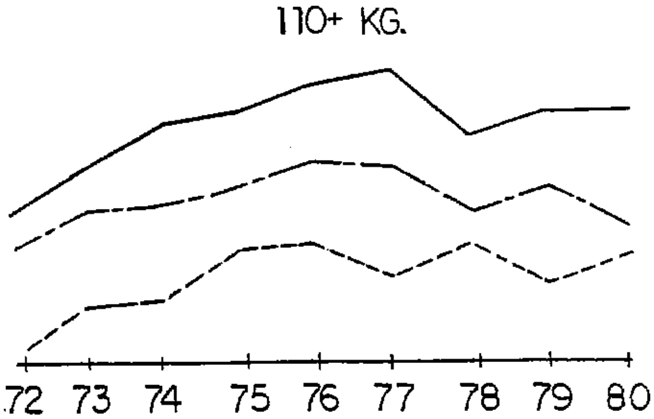
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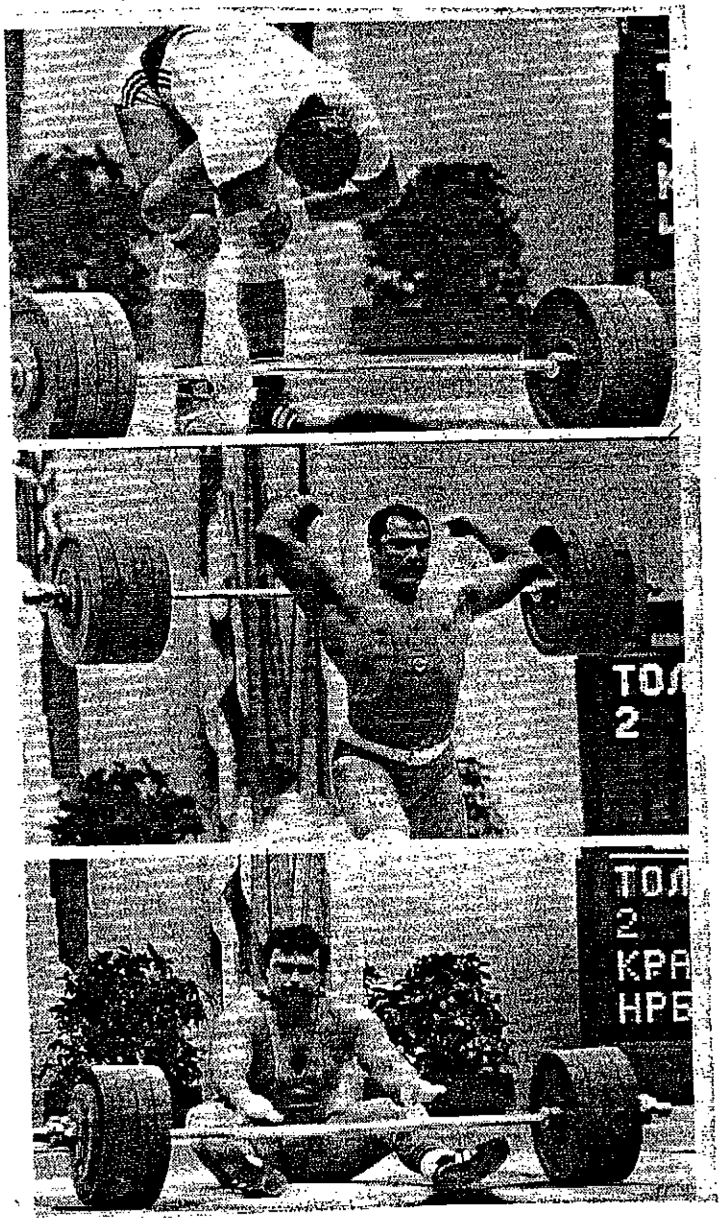
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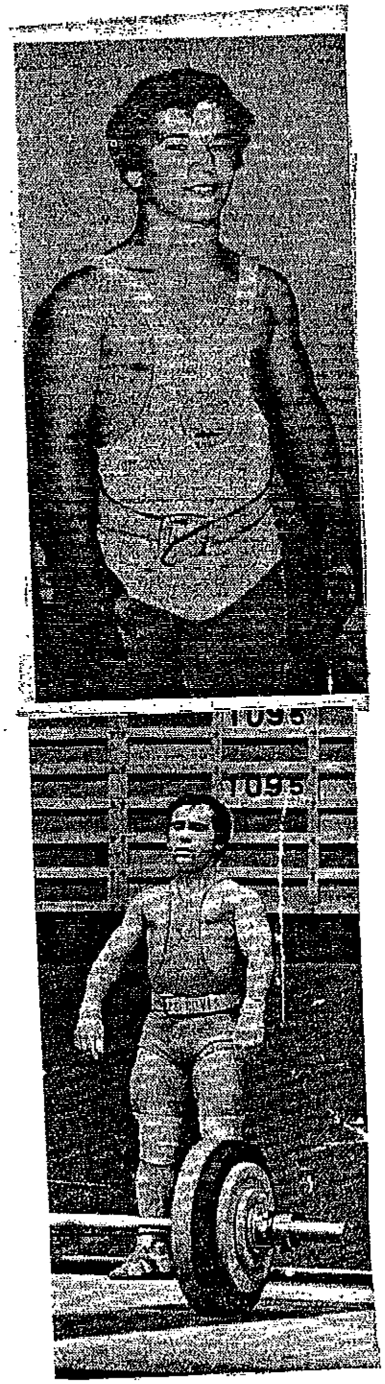


Table 2. Number of World Records in the Snatch, the Clean and Jerk and the Total, Established Within the Period 1972 - 1980.

		1972	1973	1974	1975	1976	1977	1978	1979	1980	Total	All
	S	1	1	2	3	1	1	1	3	4	17	
52	J	1	2	-	-	2	-	1	1	1	8	30
	T	-	2	-	1	-	2	-	-	-	5	
	S	2	2	-	-	2	-	-	2	4	12	
56	J	-	1	-	-	-	-	-	4	3	8	28
	T	-	1	1	-	1	-	-	2	3	8	
	S	-	-	1	4	-	-	-	-	5	10	
60	J	4	1	-	3	1	2	1	1	1	14	31
	T	-	-	1	1	1	-	1	1	2	7	
	S	-	-	-	2	5	2	-	5	2	16	
67.5	J	3	-	-	-	-	-	5	8	3	19	44
	T	1	-	-	-	-	1	-	4	3	9	
	S	3	2	2	1	3	2	-	-	4	17	
75	J	-	2	-	-	4	2	2	-	5	15	44
	T	-	3	1	-	2	1	-	-	5	12	
	S	5	3	3	2	2	-	3	6	1	25	
82.5	J	2	1	2	2	2	-	2	5	2	18	60
	T	1	1	2	1	3	-	2	5	2	17	
	S	3	4	5	-	1	-	1	-	-	14	
90	J	4	3	2	3	2	-	1	1	1	17	42
	T	1	2	5	1	2	-	-	-	-	11	
	S	World Records began					9	2	1	5	17	
100	J	recorded in 1977					2	2	2	3	9	35
	T						4	3	2	-	9	
	S	4	2	-	2	1	-	-	2	4	15	
110	J	6	3	1	3	-	-	-	-	2	15	38
	T	1	1	-	4	-	-	-	-	2	8	
Ov.	S	-	4	3	5	1	-	1	-	-	14	
110	J	2	2	7	5	2	2	-	-	-	20	44
	T	-	1	3	3	2	1	-	-	-	10	

S- snatch; J- clean and jerk; T- total.

Olympic year, there were record achievements, the importance of which has already been mentioned; the tendency to once again achieve maximum. This regularity is expressed in table 2 where the snatch, the clean and jerk and the biathlon total records for all the weight classes between 1972 and 1980 are presented.

The mean duration of world records in the snatch and the clean and jerk fluctuate in the range of 3-4 years and the total, 4-5 years. Althletes in the heavyweight classes had the largest increases in world records over the four-year period. The lighter the athlete the smaller the increases in the world records. The records in the classic exercises increased by 17.5-22.5 kg over this time period in the second heavyweight class and by 40-45 kg in the total for 60, 90 and 110 kg classes. We used the extrapolation method for prognosing the weightlifters' records. This method is more detailed.

Extrapolation means to disseminate conclusions relating any one part of a system to another of its parts.

Extrapolation is the approximate determination of any significance found outside a number of known significances (S. V. Nachinskaga, 1978).

There are several methods of illustrating extrapolation, the simplest is a graphic illustration. Essentially, there is a time scale on the horizontal axis (semi annual or annual cycles) and the athletes' results on the vertical axis. The experimental points are marked on the graph relative to the horizontal and vertical lines. The lines which connect the points represent the dynamics of the sportsmens' results. If the lines are extended farther, one can:

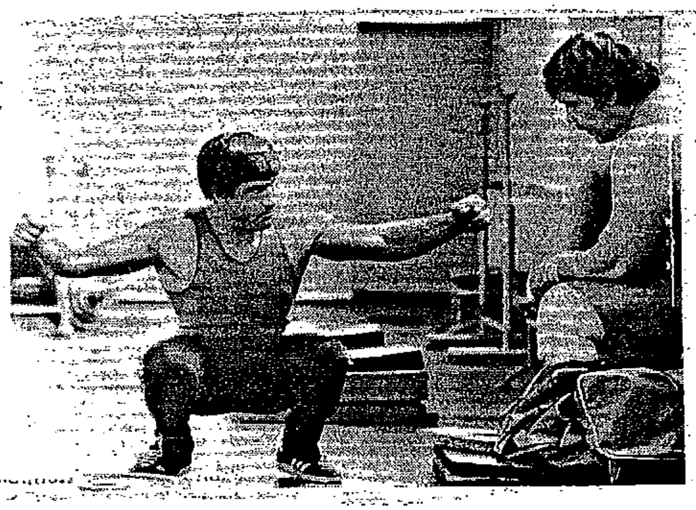
a) predict the sportsman's results;

b) determine the results we are interested in knowing when it is achieved.

This method, theoretically, can prognose other achievements in sport. The most precise method of extrapolation is the least squares method. It is a complex calculation but it enables one to construct the most precise and correct sought for line. We predicted the snatch, the clean and jerk and the total results for 1984 (table 3) with this method.

Table 3. Prognosis of Weightlifting Achievements in 1984.

Weight Class	Snatch	Clean and Jerk	Total
52	115.0-117.5	150.0-152.5	255.0-260.0
56	127.5-130.0	157.5-160.0	275.0-280.0
60	132.5-135.0	175.0-177.5	302.5-310.0
67.5	155.0-157.5	195.0-200.0	345.0-350.0
75	165.0-167.5	210.0-215.0	367.5-372.5
82.5	182.5-185.0	222.5-225.0	400.0-405.0
90	185.0-187.5	230.0-232.5	412.5-415.0
100	187.5-190.0	245.0-247.5	432.5-437.5
110	195.0-200.0	245.0-250.0	445.0-450.0
110+	210.0-212.5	265.0-267.5	460.0-465.0



Is it possible to make an error in prognosis? Yes, it's possible. The data that appears in the graph is not subordinate to the influence of social factors, i.e., they have no influence on the results of the most talented weightlifters. Because of this jumps or stagnation in the dynamics of the results are possible. For example, no one has broken R. Beamon's world record long jump of 8m 90cm set at the 1968 Olympics 13 years ago. Unfortunately there is not a more precise method of prognosing sporting results than extrapolation, but errors can be minimal. It should be mentioned that the line regularity need not be straight but can be curvelinear in form.

The question arises as to how can the line regularities be prolonged. In those fields of science where the extrapolation method is used for prognosis it is acceptible to consider that the distance to which the regularities line is prolonged should be approximately equal to the same segment as in the past. However, the most precise results are those which are located as close as possible to the end of the line. This method of prognosis is far from perfect. Coaches should rely on means of verifying results -- prognosis through the simultaneous use of several methods and then comparison of the results obtained (for example extrapolation and examination by experts' assessments). The utilization of prognosis of sport results helps the trainer to more effectively manage the training of weightlifters, sets out concrete aims and directs all of the means and methods of training to the achievement of these aims.

II. Pecularities of Weightlifters' Training After the Abolition of the Press

Reasons for the Abolition of the Press

Not long ago the sport of weightlifting celebrated its one-hundredth anniversary. The evolutionary development of this wonderful, distinctly masculine sport shows that originally there were five basic weightlifting exercises and later the so-called classic Olympic triathlon. The press was always included. Over many years this exercise served as a fundamental standard for assessing the strength of athletes. Up until a certain time (namely, before international competition) the press was not considered a complex technique exercise and, naturally, coaches began with it when teaching young athletes. Soviet specialists considered the press a purely strength exercise and in the training process used it as the first competition exercise. Successful execution of the press in competition inspired athletes to further strive for record results. The Soviet masters of weightlifting had no equal in this exercise. Vassily Alexeyev had the highest result in the press -- 236 kg.

It is known that in 1946 Soviet sportsmen joined the International Weightlifting Federation and immediately made a claim on the world championships (up until this time the world championships were dominated by the USA, England, France, Germany, Austria and others). The subsequent course of events in the struggle for world championships affirmed the superiority of the Sovet school of Weightlifting. Some members of the weightlifting federation did not like the triumphs of our lifters in the international arena. Consequently, abroad (cheifly in the USA) new innovations in training the press began (such as the strength triathlon, the continental press and the clean and jerk, technique press).

The technique press became the forerunner of that press which was designed, in the opinion of many lifters, to restore the lost glory of some countries. This exercise became a bone of contention amoungst judges (it is necessary to consider that 75% of the international category judges at this time had not been high class weightlifters and in general had questionable connections to weightlifting).

So, in the early 70's weightlifting was confronted with a difficult situation: the press was being done incorrectly (according to the rules) and judges were relying on intuition which was often the cause for subjective decisions. The athletes took advantage of the discord amoungst the judges which resulted in the press record in some weight classes approaching the clean and jerk record. This is what some of the leading specialists had to say about this:

Vice-president of the FWF J. Dam (France): "Over a long period of time the mistakes tolerated by an enormous number of arbitrations in judging the press strengthen my reasons that it is desirable to exclude the press. The press is a sore which little by little disrupts the essence of life in weightlifting. We suggest the use of cameras and mechanical devices in order to avoid this devastating action. In all of this I see half-measures, unreliable, insufficient, and difficult to execute."

R. Hoffman (USA): "Since we have great difficulty judging the press it is best that it be eliminated from competition." There was another point of view -- to keep the press in competition and change the rules. A number of arguments were advanced by the opponents of eliminating the press. First, they said only the starting strength of the press was a little more complex in the different variants of the present technique. Second, by modernizing press technique the weightlifter is able to lift more weight which leads to an increase in the amount of weight cleaned. Third, successful use of modern press technique enables one to lift weights which earlier were only dreamed of and enables the athlete to easily overcome psychological barriers. Fourth, the rise in press results induces one to increase the amount of weight in the other two classic exercises.

So, there were essentially two points of view of which the selection of one was made by the delegates to the Olympic Congress in Munich in 1972. They voted to eliminate the press. Beginning with the 32nd European Championships, weightlifting competition consisted of the biathlon.

Changes in Weightlifters' Training after the Abolition of the Press

What changes in the training and methods of preparing weightlifters took place in connection with the elimination of the press? Doctor Augustin Dzedzits coach of the Polish National team, head of the Sport Institute Acadamy of Physical Education in 1972, wrote in the Polish newspaper "Psheglond Sport": "Up until now in selecting athletes for weightlifting we have shown preference to youths with sturdy body structure, distinguished by physical strength. This requirement was conditioned by the specificity of the triathlon where besides two dynamic exercises there was also a static exercise -- the press. Sportsmen, who for example, had poor results in the clean and jerk and the snatch, because of poor mobility in the joints, could improve the total with a good press. Now, with the introduction of the biathlon, this has changed. Coaches who select athletes for weightlifting will now turn their attention to other elements. Future weightlifters should have, first of all, good physical preparation, sufficient mobility in the elbow, shoulder and iliofemoral joints. Besides this, preference will be given to youths with long muscles. Such types are characteristics of more flexible, dynamic athletes, etc. As to the changes in training methods they are as follows: previously lifters spent 40% of their training time trying to improve the press. Now, the training load will not be decreased. The freed up time will go to improving the snatch and the clean and jerk. The leg and back muscles play the chief role in both exercises. The press to a large degree developed the muscle antagonists -- the muscles of the shoulder girdle. Now, weightlifting training should include elements of the press but to a lesser degree. The role of the general-developmental exercises rises. The physiques of contemporary weightlifters will perhaps be held in esteem (wide shoulders, powerful muscles, etc.) but they are not always handsome. Evidently, weightlifters will soon resemble track and field athletes, their physiques will be functionally more proportional. This will be due to the content of weightlifting training, its new quality. Success in weightlifting will not necessarily be achieved by the strongest but, by the best physically and technically prepared, the most dynamic athletes."

It is obvious from the aforementioned quote that specialists are still not prepared to answer the question as to what should be the training model for weightlifters after the abolition of the press.

The following analysis of training after the press appeared in the Bulgarian journal "Questions on Physical Culture": "It is necessary to a significant degree to change the educational-training work by raising the amount of weight in connection with the exclusion of the press. In order to arrive at the correct conclusions on restructuring the educational-training work and to avoid mistakes the results of the six best athletes in each weight class at the Olympic games over the last 20 years (1952-1972) were analyzed. We observed an increase in results in all weight classes. The largest growth in results obviously occurred in the press. The press results doubled in comparison to 1.5 times for the snatch and the clean and jerk over the 20-year period. At the same time the increase in the clean and jerk was 25% more than the increase in snatch, although this increase was less then the increase in the press. Thus, the press improved the most, then the clean and jerk and lastly the snatch in the last 20 years. This, naturally, was due to a large degree to the fact that at this time weightlifters trained more on the press and its assistance exercises. Besides this, the phenomenal rapid development of the press took place through a reduction in the volume of assistance exercises for the snatch and the clean and jerk and was furthered by such factors as the achievements of science in the area of strength development. You see, it is known that strength is the fundamental physical quality that is a necessity for weightlifters. Much training time was devoted to development of this quality. Later as technique was perfected and the elastic qualities of the apparatus were utilized, the press was converted from a strength movement to a tempo exercise, very similar to the clean and jerk, since besides the arms, the sportsman's whole body is brought into action."

It is obvious from this article that Bulgarian specialists devoted considerable analysis to the reasons for the lag in the snatch and the clean and jerk results. But their conclusions are still not completely logical; and there are no concrete recommendations about the contemporary training of weightlifters. One thing is clear: the Bulgarians recognized the necessity of eliminating the press. However, in their analysis they unfortunately do not consider the fact that contemporary (after 1972) sportsmen preserved a reserve of strength acquired through pressing and press exercises.

There is still a lot that specialists have said about the peculiarities of training weightlifters after the abolition of the press. Knowledge of the regularities of the distribution of training means and methods in the biathlon aids in more unidirectional management of the training process and the sporting form of weightlifters.

In our opinion the article "The Biathlon, Problems, Perspectives" published in the 1974 Weightlifting Yearbook deserves considerable attention. It gave a similar analysis of results in the biathlon after the press was abolished. Considerable time had already passed, as stated in the article, since weightlifters began training on the biathlon. What were the increases in the snatch and the clean and jerk like during this period? The best world and European results in the snatch, the clean and jerk and the total for the triathlon were compared to these same parameters for the last European championships. The snatch results in the 52, 56, 67.5 and over 110 kg class were lower than earlier results, the same in the 60 kg class and 2.5 kg more in the 75, 82.5, 90 and 100 kg classes. Results in the clean and jerk in the 52, 60 and 67.5 kg classes were lower, the same in the 75 kg class and 2.5 kg more in the 56, 82.5, 90 and 7.5 kg in the 110 and over 110 kg class. Biathlon totals were 10 kg lower in the 52 kg class, 5 kg in the 60 kg, 10 kg in the 67.5 kg and 5 kg in the 90 kg class; lifters increased the total by 5 kg in the 56 and 75 kg classes, 2.5 kg in the 82.5 kg, and 7.5 in the 110 and over 110 kg classes.

Thus, results decreased slightly in the first four weight classes. The remaining weight classes increased their results slightly. However, the rapid increase, some specialists expected, had as yet not been observed. The rate of increase in the snatch and the clean and jerk remained as before during the triathlon.

However, changes in training methods followed the abolition of the press. These changes make it possible to preserve the previous rate of increase in the snatch and the clean and jerk. Well then, the chief task at the present time is the search for the most effective means of managing training in the biathlon in order to further raise sporting results. Despite the fact that considerable time has transpired since the press was eliminated the question remains: is it necessary to include pressing exercises in training, in what volume or can one do without them?

Weightlifters who do not do presses in training appear "cone shaped" with a narrow insufficiently developed shoulder girdle and hypertrophied lower extremities. This apprehension is groundless since the majority of coaches and athletes continue to include the press and special exercises for the press in training. At the present time pressing exercises comprising approximately 20% of the general volume of all exercises in training is considered acceptable. It has been established, experimentally, that a decrease in these exercises to 10% of the load furthers a larger increase in the clean and jerk than in the snatch. One should bear in mind here that some high class athletes competed during the press era and have sufficiently well developed shoulder girdles. And, if a reduction of the volume of pressing exercises to 10% is appropriate, at the present time, for increasing the clean and jerk then this means the same should be true for the volume of exercises in the biathlon. As of yet, it is not known what the long term results of training on the snatch and the clean and jerk with an insignificant volume of pressing exercises will be. The chief recommendation to coaches is in decreasing the volume of pressing exercises is to see how this affects the jerk.

Some weightlifters have stopped doing presses and increased (by this volume) jerk exercises. Is such a substitution appropriate? As of yet this question is difficult to answer. It is known, that 70-80% weights for 15-20 lifts are necessary for training the jerk. Weights of 70-80% in the clean and jerk correspond to approximately 90-100% weights in the press and such weights are lifted 10-20 times per month. Consequently, it will be necessary to execute this number of lifts in the jerk, in training.

In the triathlon the volume of jerk exercises was 18% of the general training volume and approximately 1/3 of these (6%) were jerks i.e., weightlifters who had poor jerks. Practice shows that, at the present time, not all athletes are well prepared at such a large number of lifts in the jerk. On the basis of this, it is apparently, necessary to increase the volume of jerks. But, in order to restructure the training for the clean and jerk one also needs to determine the time.

Thus, it is up to the athlete and the coach to consider that it is not necessary to do the classic press in training: other pressing exercises, which strengthen the arms and shoulder girdle, can substitute for it. Special pressing exercises are helpful in perfecting jerk technique. Consequently, the increases in the clean and jerk now will depend upon the correct distribution of the load in pressing and jerk exercises. It is necessary to establish their ratio as soon as possible.

Today's question is the rejuvenation of the national team. Older athletes have achieved high results in the press. As older athletes' results in the press rose triathlon totals also increased rapidly. In the biathlon success is determined not by the press but by the quick lifts. Therefore, it is necessary to develop speed-strength qualities in training, and they, as is known are developed faster in younger athletes. What can be said about this? One author as usual extols the press as a stimulus for improvement, another, apparently in order to renounce his assertions.

Drawing special attention to this matter, two-time Olympic champion, five time world champion, merited master of sport, merited coach of the USSR, medical doctor, professor A. N. Vorobyev wrote in an article "And Hercules Needs Help" published in Moscow Pravda (January 22, 1974): "What is the reason for the 'strain' in world weightlifting competitions? We believe there are two. The first is the abolition of the press. As is known, Soviet athletes were always successful in this movement. Besides this, the abolition of the press decreased interest in weightlifting since the main strength exercise was eliminated from competition. One can only regret the International Weightlifting Federation's hasty decision. Experience with the biathlon competition indicates that the abolition of the press was unjustified and it is necessary to once again return to the triathlon. Until this question is resolved we need to search for means and methods of improving the training for weightlifting and continue to perfect the sport-technical mastery of athletes by managing the training process and the sport form of sportsmen."

What volume of pressing exercises should be utilized in training for the biathlon? According to R. A. Roman's data (1974) the mean distribution of the various traithlon exercises in the competition and the preparation months for sportsmen of various qualification comprised: presses - 30, snatches - 22, clean and jerks - 16, squats - 17, snatch and clean pulls - 13, and other exercises - 2% of the general volume. According to Roman decreasing the volume of pressing exercises to 10% not only does not decrease progress in the clean and jerk but promotes greater improvement in the clean and jerk than the snatch. For the biathlon, Roman suggests the following exercise ratio: snatch - 27, clean and jerk - 26, press - 10, suqat - 20, pulls - 15, other exercises - 2%.

Pressing exercises are special-assistance exercises. They strengthen the arms and shoulder girdle. Pressing exercises utilized most are: classic press, press behind neck, narrow and wide grip press, bench press, seated press and push press. The last exercise according to coaches is more important for athletes who have difficulty "fixing" the barbell after jerking it overhead. R. A. Roman believes that presses should comprise 10% of the general monthly volume of all exercises in both the prepatory and competition months. We believe more presses should be done in the prepatory than in the competition period.

Coaches can utilize the following recommendations in planning the relative proportion of pressing exercises in training.

1. The minimal training weight in the press, seated press and incline press for qualified sportsmen should be 60%, and in the bench press and push press it should be 70% of the maximum press.

2. The maximal weight for the push press should be equal to the limit press, 75% for the seated press, 90% for the incline press and 105% for the bench press.

3. The number of pressing lifts in training (one workout, Ed.) should be 6-20. The amount of weight used depends on the

number of lifts in jerk exercises:

4. The number of lifts in pressing exercises should not exceed 4 with 90%, more than 3 with 95% and more than two with 97-100% weights in training. Lifts with maximum or submaximum weights are recommended no oftener than every 7-10 days. The general number of such lifts should not exceed 10 in one month.

III. Questions of Managing Training and Sporting Form of Weightlifters

Chief tasks of managing and determining the notions "organization and direction of training".

The further development of weightlifting and the necessity of perfecting the system of preparing highly-qualified athletes in our country and abroad is advanced in the first order by the search for new means and methods of training which permits the rise in the already high sporting results. In the last ten years many coaches have gone the optimization of sport training path by utilizing in their work the ideas and methods of cybernetics for scientific guidance.

Organization of training is understood to mean the structure of the training scheme which includes the determination of its means and methods.

Managing (in broad sense of the word) is the sum total of coordinated measures designed to achieve a certain goal. This can be related to sport: the goal -- this is the competition, and measures -- these are the educational-training sessions and selection for weightlifting preparation.

Let's look at how they came up with the notion "managing" in cybernetics. For example, academic A. I. Berg writes that in the modern stage of researching the intricate dynamics of a system (as is the human organism) and processes, the most general notions of management come from cybernetics. It summerizes the regularities of management occuring in nature and society.

In essence, the process of management enables one to stabilize the system, preserve its qualitative definitiveness, preserve its dynamic equilibrium with the environment and secure its perfectioning to achieve the desired effect. In other words, the process of management is none other than regulation of the system, in this case -- the system of managing the training process.

At the present time high performance sports all work closely with science and simultaneously turn to really creative activities. As an outcome of the latest scientific research in weightlifting the sport training process has solved the following problems:

a) achieve the highest sporting results for the given sportsman; b) achieve this result in the shortest time; c) achieve it such that the athlete makes this result at precisely the time planned; d) expend as little strength as possible in doing this.

It is known that management of sport training is only possible under the following conditions: the presence of a managed or manageable system, the presence of a direct channel and the reverse connection and a constant frequency of information along this channel. In cybernetics the process of management is realized with a team (program). In sport training it is realized with physical exercises. Out of all the diverse means of achieving established goals it is necessary to select those which are most appropriate at the given moment. Contemporary levels of sporting achievements require a systematic approach to managing the training of sportsmen. In this systematic approach the sportsman's body is regarded as an intricate, dynamic, self-regulating system, consisting of managing and managed subsystems.

Sport training has a multitude of features inherent to the process of managing complex systems. In the preparation period, as has already been noted, sportsmen are confronted with the task of achieving high results over a certain period of time at a certain date.

Since sport results are generalized indicators of the systems of the organism's functional possibilities (level of preparedness), it is necessary to change the state of the organism as a whole or several of its subsystems. These changes should not be arbitrary but only those which make it possible to achieve the planned state and secure higher sporting results. Consequently, the task of managing (in the narrow sense of the word) in this context amounts to transfering the athlete's body from one (initial) to another (planned) concrete state.

This transference is realized through the influence (on the sportsman's body) of systematic exercise i.e., the means and methods of sport training. V. V. Petrovsky (1973) showed that in order to trasfer an athlete's systems from one state to another it is necessary to resolve the following tasks:

to know which state the athlete is in at the beginning of the management (supervised training, Ed.) and to have a description of this state;

to have a description of the state the organism's systems need to attain;

to have quantitative (figures) characteristics of the system's state.

Management of training based on quantitative characteristics of initial and planned states is realized through determination of indices which distinguish them, selection of those indicators which are subject to changes and selection of the means of controlling them; based on this account, construct and direct change in the organism's systems which can be subjected to analysis and assessment.

V. V. Petrovsky suggests four indicators for assessing the effectiveness of training management:

percent improvement in planned results relative to initial;

preciseness of achieving planned results at the time needed;

number of training sessions necessary for achieving the planned results (the fewer the number of workouts the higher the effectiveness of the training);

duration for which results at the planned level are held.

When organizing the management of training one ought to consider in preparing for competition that various disruptive factors (work or living conditions, diet, means of restoration and so forth) can affect the sportsman.

In order to avoid the undesirable influence of disruptive factors the coach should arrange a system of control which would aid in obtaining crucial and periodic information concerning the athlete's state of trainability. Such control can be achieved through the use of special devices, control exercises -- tests; permiting the assessment of the sportsman's state of trainability as a whole or the individual systems of his body at a certain stage of training.

The complexity of managing the process of sport perfectioning consists of this: the development of any morphological and functional reconstruction of the athlete's body can only be achieved gradually, through physical exercise and muscular loads. Therefore, training loads are those factors which to significant degree affect the effectiveness of managing the training process.

It should be pointed out that a distinguishing peculiarity of the body is its rapid adaptation to repetitive similar influences which bring a halt to provoked accommodative morphological and functional displacements. Therefore, at the present time specialists conclude it is not the volume of work but the correct construction of the training system in the diversity of physical exercises that is especially important. The reason being that in many types of sport, including weightlifting, a significant part of the reserves for "mechanical" increasing of the training loads are almost exhausted.

It follows from this discussion that management of sport training consists of making-up an individualized program of preparation for a concrete competition and its realization. The programs should be corrected constantly in accordance with the dynamics of the athlete's trainability in the process of training. Therefore, it is expedient to systematically adjust the actual execution of the training plan by comparing it with the planned. Balancing the training program with the state and capabilities of the athlete is the essence of management (N. G. Ozolin, 1970).

Sporting Form and Trainability

Sport training -- this is the process of systematic influences to the athlete's body to achieve and preserve work-capacity as well as endurance through the actions of various external and internal factors of the environment. Under the influence of sport training accommodative changes take place within the athlete's body which increase the reserves of the organism's functional capabilities. The ability to quickly and fully mobilize these capabilities, achieve the highest degree of coordination of vegetative and motor functions, and the establishment of the optimal correspondance between vegetative displacement character and the intensity of physical loads are perfected (S. P. Letunov, 1963).

Through systematic training the physiological displacement to the organism, simultaneously with the perfectioning and automization of motor skills, the development of physical qualities, technique and tactics raises psychological preparedness. This entire complex results in the gradual development of trainability and the achievement of sporting form. Sporting form is the state in which the athlete is optimally (best) prepared to achieve sport results. Quantitative changes yielding a qualitatively new state should be considered the result of acquisition through training.

Sporting form is characterized by a complex of physical-medical controls, psychological and integral characteristics indicative of a high development of physiological functioning and the harmonious activities of all the organism's main systems. One can only say that the sportsman is in sporting form when these components are present and they are in harmonious balance (G. M. Kukolevsky, 1975, L. P. Matveyev, 1966, 1977).

N. G. Ozolin (1970) introduced the concept of "high sporting form" the foundation of which is that sporting form should be acquired at the beginning of the competition period, and since during training all of the components consolidate, improve and are perfected, then the possibility of achieving high results increases. This level, which coincides with the highest sport achievements, the author calls "high sporting form".

Judging by the literature this concept has been widely accepted. L. P. Matveyev (1966) correctly noted that sporting form can be neither excellent nor poor. What can be better than the best? If the sportsman does not produce the results he is capable of this does not indicate he is in poor sporting form but that he is lacking. Consequently, N. G. Ozolin's term is not very precise, in our opinion.

There is no unified and comprehensive opinion among specialists concerning the concept of trainability in sport. Thus, a number of authors consider trainability a measure of the organism's adaptation to certain work, achieved through training. And, other authors consider trainability to be the level of special work-capacity. V. M. Zatsiorsky (1971) understands trainability to be a permanent characteristic state of the athlete that is a reflection of his capabilities in the chosen sport. N. G. Ozolin (1970), G. M. Kukolevsky (1975), V. A. Geselyevitch (1976), V. S. Keller (1977) collectively characterize the concept of trainability most fully. They understand it to be a complex state of the athlete's organism characterized by a high level of developed functional capabilities which in combination with the technical, tactical, physical and psychological preparedness determines the potential to produce high results in a concrete type of sport.

In the process of developing trainability, the functional state of all the body's organs and systems, the activities of the central nervous system (which unites the functions of all the organs into a unified whole) are perfected. Therefore, it is impossible to deny the fact that trainability, as a quality of the organism, is nevertheless a biological category (I. V. Aulik, 1977). The author suggests that trainability be viewed from several aspects: pedagogical, medical, psychological and social. The athlete's technical and tactical preparedness come under pedagogical aspects; under psychological -- the athlete's psychological state, moral and volitional qualities; under medical -- the organism's morphological indices and state of health; under social -- the sportsman's position in life, his living conditions, motivation for training for a certain sport and various qualities of character.

It is obvious from our review of the literature that the majority of authors are of the opinion that trainability is a complex state, reflecting all of the organism's functions.

According to the theory of sport training the development of trainability can be divided into three stages: first -- the growth of trainability, second -- the achievement of sporting form, third -- the decrease in trainability. Each of these stages corresponds (with a certain degree of probability) to periods of training -- prepatory, competition and transitional. It is not difficult to conclude that these periods are sequential stages in the process of managing sporting form (L. P. Matveyev, 1966, 1977).

Specialists are interested in the question -- what is the similarity and what is the difference between sporting form and the state of trainability? Common to both of them, in our opinion, is that the level of trainability is the base for sporting form. One can say that sporting form is one of the stages in the development of trainability, i.e., comprising a part of trainability, enabling one to achieve high sport results in competiton. Besides this, sporting form and the state of trainability are complex concepts and reflect all of the functions of the athlete's body. Sporting form corresponds to the highest level of trainability.

The differences between them is as follows. First, a character trait of sporting form is the given sportsman demonstrates high sport results, while the state of trainability secures the achievement of certain results -- not necessarily the highest. Second, sporting form as one phase in the development of trainability can not be maintained for very long. There is a point in training where it is surely lost. The state of trainability is preserved throughout the entire training period of the sport. It reaches the highest level in the sporting form period, decreases in the transitional period or when sport activities cease temporarily.

Prolonged Preservation of Sporting Form and Its Connection to the Periodization of Sport Training

As has already been noted the process of development of sporting form represents an alternation of three phases. These phases are alternated again and again over the course of many years of training, but, as is correct, to a higher degree. Let's look at the characteristics of these three phases in detail. The development of sporting form phase consists of two sequential stages: formation of the prerequisites of sporting form and its direct formation. The beginning stages of sporting form are characterized by the most significant changes in the organism as expressed by the rise in the general level of its functional capabilities as well as in the renewed and renovated stock of motor coordination. Here the foundation of future sporting form is laid down, the quality of which determines the level of the athlete's achievements in a given cycle of sport perfectioning.

In the second stage -- direct formation of sporting form, the changes acquire a more specific character as though concretized. The rise in special trainability, the development of special motor qualities specific to weightlifting, further perfectioning of sport technique and tactics are the basic directions of adaptational changes. The separate components which make up the preparedness for high sport achievements combine in an integral, clearly harmonious system -- sporting form. The phase of relative stabilization or preservation of sporting form is characterized by an optimal preparedness for sport achievements (relative to the given degree of sport perfectioning) and lasts from 2 to 4 months. There are unavoidable fluctuations in trainability in the sporting form period. They can be caused by premeditated undulating changes in the training loads and many other reasons (illness, injury, etc.). These small fluctuations are distinguished from the true loss of sporting form. The phase of brief loss of sporting form is distinguished by a slump in trainability, extinction of connections uniting the individual elements of sporting form and the transference of the organism to a different level of functioning. The character of the athlete's activities change. There is reason to believe that the various components of sporting form are not lost simultaneously. All the coordination connections became extinct earlier. The basic motor skills and the elevated level of the athlete's functional capabilities are preserved for a longer period of time. The degree of diminished trainability during the loss of sporting form period depends upon the length of this period and the character of the training. An athlete is able to preserve trainability at a higher level than that at which the first phase in the development of sporting form began if he utilizes the means of active rest. Passive rest leads to an unwarranted loss of sporting form. Considerable time is expended subsequently compensating for such a loss.

The loss of sporting form is not a decline in the life functions of the organism. With a rational, organized training regimen it occurs as a part of the usual life-activities. Some positive reconstruction, provoked by the preceding training loads, occurs within the organism in this period. Among athletes the question often arises as to why sporting form, which is the athlete's optimal state, is not preserved constantly? Is it a mistake to ask this when sportsmen take considerable time and energy acquiring sporting form, then lose it?

This question can be answered so. Sporting form acquired through this or that degree of sport training is an optimal state for a given stage of training. But, that which is optimal at one degree of sport mastery is not at another, higher degree. For example, an athlete executed the norm for class I; but, to execute the norm of candidate for master of sport requires a higher optimal state and mastery of a new stage of trainability, necessary to execute the new norm. Therefore, trying to preserve the acquired sporting form "forever" is tantamount to always striving to remain in the same place. In order to move forward, one needs to secure further development of physical qualities, possess new, more perfected habits and skills and raise all aspects of sport preparation. And thus, the old sporting form as a relative stable system of certain components will be lost. The new sporting form arises from the foundation of the old "constructed material" but, in itself, includes new acquisitions supporting a new higher level of the athlete's development. Thus, the brief loss of sporting form is a condition of its further development.

As is known, sport training is inseparably linked with the expenditure of the organism's working potential and fatigue. Fatigue is not only an unavoidable consequence of training but an obligatory condition for raising sport work-capacity. Everyone knows that one of a weightlifter's fundamental physical qualities -- strength -- is achieved through fatigue. The growth of an athlete's general work-capacity if achieved through fatigue. However, this statement is only true when training loads and rest are alternated correctly. The athlete significantly increases the intensity of the load and up to a certain point preserves its volume as he acquires sporting form.

When the sportsman is in sporting form and systematically enters competition the intensity of the load is not decreased. As a result of the strains of training and competition fatigue accumulates and a protective reaction arises against the overstraining of the accommodative mechanisms. If, under these conditions, one attempts to improve sporting form, then one can become over-trained. Therefore, a transitional period is included in the training process where the sportsman is assigned active rest. This period conicides with the brief loss of sporting form.

Yet another circumstance needs to be considered. The organism's various functions are in intricate dynamic equilibrium with each other and with the external environment. Maintaining this equilibrium during the sporting form period, when the sportsman is mobilizing his capabilities to the limit, is a very difficult task and it can be beyond one's strength if this is demanded constantly.

Various (provoked by training) biological reconstructions within the organism do not occur simultaneously. The long term use of training loads does not exclude functional disturbance of the organism's different systems. For example, cases are known where susceptible athletes who were in sporting form catch a cold. This leads us to believe that sporting form is not a criterion of health. Of course, this is not to say that sporting form predisposes one to illness. A lack of correspondance between high work-capacity and insufficient resistance to disease is possible in periods other than sporting form. They can intensify in this period, through attempts, by means of intense training, to hold sporting form for an excessively long time. For the most part, it is well known that athletes possess robust health and a greater resistance to unfavorable influences than the non-athlete.

Thus, we can state that although sporting form is an optimal state this state is not constant. The path to the achievement of a new, higher level of sporting form, inevitably proceeds through the loss of the old. The length of time necessary for the acquisition and preservation of sporting form depends on the type of sport, the competition calendar, method and regimen of training, state of the sportsman's organism, daily regimen, diet, and the means of restoration. Sporting form can be preserved for a period of 3-5 months only if one strictly observes the fundamental principles of training during this period. According to L. P. Matveyev's data (1966) the length of the phase of sporting form development depends upon what sort of cyclical principles the construction of the training is based on (yearly on semi-yearly).

An example of the length of the development of sporting form phase for the yearly cycle is: creation of the prerequisites for the acquisition of sporting form -- 5-7 months, relative stabilization of sporting form -- 3-5 months, loss of sporting form -- up to 1.5 months; the corresponding figures for the semi-yearly cycle are: 4 months, 1.5-2.5 months, and 3-4 weeks. The semi-yearly cycle is the most optimal for weightlifters. However, qualified sportsmen enter into sporting form 3-4 times a year, frequently fall and winter. This does not exclude the possibility of achieving high results in the spring and summer. Some Soviet weightlifters, for example, A. Voronin, D. Rigert and V. Alexseyev successfully held sporting form over several months in succession and established world records in each competition. Consequently, such regularities can be seen in weightlifting: the periods of acquisition and stabilization of sporting form are shortened somewhat (2-3 months) but repeated several times in the semi-yearly cycle.

As for the question of achievement of sporting form, one is guided by the competition calender. One plans athletes' preparation taking these dates into consideration. In addition to the most important competitions of the year (USSR, World and European

Championships) weightlifters take part in lower scale competitions. The competition calendar is conditioned by the length of this or that competition period, so, the length of sporting form preservation can vary from 1-2 to 6-7 weeks.

The Criteria of Sporting Form and the Trainability of Weightlifters

The problem of correct assessment of sporting form and the state of trainability is of no less importance than the achievement of these states. Specialists believe that the most integral indicators of weightlifters' sporting form are sport results. According to L. P. Matveyev (1977) sporting form can be judged effectively from sport results only when they are demonstrated with a certain frequency under comparable conditions and assessed by objective indices (measures). With respect to this, the selection of quantitative criteria of sporting form is of theoretical and practical importance. L. P. Matveyev divided the criteria into two groups: progressive and stable. The progressive criteria characterizes sporting form by the amount of increase and the absolute levels of the sportsman's achievements. The indices can be:

a) difference between the individual achievements of the previous large training cycle and the results achieved in the current cycle. There may be no improvement for athletes in the 7-10 year stages of training. In this case the sporting form index will be a repetition of personal records or results close to this level (in the 1-3% range).

b) difference between the results of a control competition and results of the first competition of the large training cycle.

The stable criteria are characterized by the following indicators:

a) quantity of the results, demonstrated by the athlete, within the determined zones of sporting form. The lower limits of these zones, in a number of acyclic speed-strength types of sports (related to weightlifting), should be no less than 95-97% of the personal records of qualified athletes. If the results, with sufficiently frequent competition, are higher than a given level then this is the basis for preserving sporting form;

b) average time interval between results which lie within the sporting form zones, i.e., the frequency with which the athlete demonstrates results which are not less than the lower limits of the given zone. The larger such results and the shorter the time interval between them the more stable the sporting form;

c) general length of the period, over the space of which, sport results do not decrease below a certain level is taken as the limit of the zone.

The informativeness of the stability index depends, naturally, on the frequency with which the athlete enters competition. In view of the fact that sport results do not enable one to selectively control the separate aspects of training there is now a search for additional sporting form criteria. Specialists believe these criteria should characterize: the functional state of the important organs and systems, the degree of variability and the dynamics of restoration; the developmental level of basic physical qualities; the level of technical mastery.

Since sporting form includes certain aspects of preparedness, L. N. Sokolov (1974) specified the importance of each for weightlifting. He placed physical preparedness first, then technical, psychological and tactical. He ranked the significance of the separate physical qualities so: strength, speed, endurance and flexibility. Thus, there are a number of additional criteria which characterize sporting form and the state of trainability.

One often finds several groups of methods of studying trainability in the methodological literature: pedagogical, medical and mixed, (where both types of control are utilized). Thus, I. V. Aulik (1977) recommended that strength and speed be determined in order to assess the trainability of weightlifters and to obtain objective information about the functional state of the muscle system, i.e., measure the strength of the athlete's basic muscle groups.

Special-physical preparedness is one aspect of a weightlifter's preparedness which a number of specialists (A. V. Chernyak, 1970; M. P. Mikhailyuk, 1971, R. A. Roman, 1974, 1978 and others) recommend be assessed with the special-assistance exercises utilized in training. The majority of assistance exercises are closely connected to the classic exercises. Photographs, movies and recently, video-recorders are utilized extensively in weightlifting to assess technical preparedness. In addition, some coaches utilize specially constructed devices and apparatuses to obtain information about the movement in space of the athlete-barbell system, its speed, acceleration, and amplitude, for the assessment of technical mastery.

Psychological preparedness is determined by medical methods. The simplest methods of measurement are utilized for testing neural activities and individual psychological qualities: reflexometria, tapping test, tremometria, attentiveness and motor analysis.

Thus, coaches not only can utilize the basic criteria of sporting form -- sport results in practice, but also additional criteria -- test indices which reflect the level of the basic components of a weightlifter's sport mastery. Complex assessment of the sportsman's state contributes to the achievement of the desired aims -- demonstration of the highest results in competition at precisely the date planned. Of course, this work requires certain knowledege and skills as well as time. But this time is undoubtedly justified to win the Olympics, World and European Championships.

Peculiarities of a Weightlifter's Training in the Competition Period

After athletes acquire a state of trainability it is necessary to preserve this level in the competition period until competitions begin, during them and then to realize their functional capabilities by achieving higher sport results. In weightlifting, the competition period is distinguished from other periods by its purpose. As is correct, the general volume of the training work

work decreases at this time to compensate for the increased intensity. All sides of the athlete's preparation com especially close together. The pre-competition stage has special significance in the training process because much of the success in competition depends on it. The basic task of the competition period is the completion of the athlete's trainability up to the level of sporting form and its realization in sport achievements (R. A. Roman, 1974; A. S. Medvedev, et al, 1979). Resolution of this task requires the complex use of the various means and methods of management as well as extensive utilization of different restoration factors to secure a high work-capacity and to preserve it throughout the entire competition period.

Let's use the USSR national team's preparation for the Montreal Olympics as an example. In the concluding stage, the team trained with weights eight times a week and did general-physical preparation two-four times a week. The month prior to departure for Montreal, the number of workouts with the barbell were reduced to five a week. During the first two weeks of this month a large volume and by comparison a low intensity load was utilized (4-8 lifts per set). After that the athletes trained four-five times per week with the barbell and did general-physical preparation twice a week. The intensity of the load was increased significantly and the perfectioning of technical mastery was stressed (Y. A. Sandalov, I. S. Kudyukov, 1977).

The length of the competition period depends on the competition and fluctuates from 2-3 to 6-7 weeks. Sportsmen ceased the traditional three sessions a week when the volume of the training load was increased. Now the majority of weightlifters train five-six times a week and from 15-20 days before competition -- three-four times a week. On the average, there are 13-18 workouts in the competition period.

Some weightlifters train twice a day at the beginning of the competition period. According to A. N. Vorobyev (1977), two-three workouts per day is appropriate only if the necessary complex of restoration means (rational diet, physiological means, etc.) is utilized.

The number of exercises is decreased (especially in the last two weeks before competition) in the competition period. Good mornings, pressing exercises, squats with heavy weights, etc. are excluded during this period. With the reduction of the strength exercises, training basically becomes speed-strength in nature. As a result, favorable conditions for the restoration of the organism are created (A. V. Chernyak, 1978). In the competition month the loads are distributed by weeks according to the following scheme: 4th week - 35%, 3rd week - 28%, 2nd week - 22%, 1st week - 15% of the general volume of the monthly load with a gradual decrease up until the day of competition. This scheme for the weekly micro-cycle is utilized by Soviet and Bulgarian weightlifters.

The training load in the competition month depends on the training load in the preceding month. According to A. V. Chernyak (1978), when the volume of the load in the pre-competition month is high (more than 1,300 lifts) it is decreased by approximately 20-30% in the competition month. Three variants are possible when the load is average: the load either stays the same, decreases or is increased by 10%.

The last large load usually occurs 13-17 days before competition. At this time, lifts with near-limit weights are executed in the classic exercises in order to determine the level of preparedness. Based on the results of these control assessments the first attempts in competition can be adjusted. In the majority of cases, competition success depends on this. The athlete should be in sporting form at this time (from 13-17 days before the competition) and be prepared to make his best training lifts in the snatch and the clean and jerk.

The maximal clean and jerk is usually done at an earlier date than the maximal snatch. The clean and jerk maximum is done 10-12 days before competition and the snatch maximum is done 7-9 days before. These times can vary depending upon the athlete. The basic aim of the last two weeks of training before competition is the restoration of the organism from the influence of large loads and to prepare it for competition.

Optimization of Training Loads as a Factor of Managing the Training Process

A central question in sport training is the selection of loads adequate for the athlete's potential, in other words, the selection (for a certain state) of such loads which yield the greatest effect in the achievement of sporting results (A. N. Vorobyev, 1974). The growth of achievements are closely connected with the functional capabilities of the organism. Raising or lowering functional state depends upon the character and magnitude of the training loads.

Highly-qualified weightlifters do 20,000 lifts a year of which 480-500 are with 90% and more of maximum in the classic and special exercises. A further raising of sport achievements by means of increasing the volume of the training load will be less effective. Therefore, it is important for the coach to skillfully determine the optimal volume of the load in the different training cycles by taking into consideration the individual peculiarities of the sportsman's organism.

It is also necessary to keep in mind that large training loads are only appropriate if they bring the athlete's qualitative indicators to new levels. We know that this does not always happen. Because of individual miscalculations in dosing the loads, the inability of the coach and athlete to precisely determine the qualitative level of sporting form at a given date, annoying disruptions in crucial competitions occur, because of which athletes now and then, "bomb out".

The training load is divided into external and internal aspects (D. Kharre, 1971). The external aspects are determined by the volume and intensity of the applied means (general-developmental and special exercises) and the internal by the magnitude and character of physiological and biochemical changes in the organism and the degree of the sportsman's psychological tension under the influence of the applied means.

At the present time, the external aspects of training loads have been most fully researched. The displacement to the athlete's organism after loads of various intensity has been studied somewhat less. In our opinion, it is necessary to consider both the external and internal aspects of the load to effectively manage training and sporting form. Training loads of the best weightlifters, in recent years, are characterized by large variety. A. D. Ermakov and N. S. Atanasov's data (1975) of the distributions of the loads in two pre-competition month cycles of highly-qualified weightlifters (780 cases) is presented in table 4.

Table 4

Distribution of Loads Relative to Maximum Snatch and the Clean and Jerk of Qualified Lifters

Exercise	Loads %										
	up to 55	55	60	65	70	75	80	85	90	95	100
Snatch	0.83	0.0	4.08	6.19	11.7	11.7	14.5	22.9	16.7	8.9	2.5
C & J	1.36	1.86	4.82	7.88	8.18	16.6	14.9	18.4	12.7	11.0	2.3
Mean Data	1.09	0.96	4.45	6.99	9.91	14.1	14.7	20.7	14.7	10.0	2.4

The data in the table indicates that the 85% lifts are done most. 85% is used 22.9% in the snatch and 18.4% of the lifts in the clean and jerk. Analysis of the competition mesocycle indicates that more than 50% of training consists of assistance work. The fundamental weights for pulls are 95-100% although the most effective weights for strength development are 70-90%.

V. I. Frolov (1977), obtained some interesting data by comparing snatch technique (90%) and snatch pulls (90, 100, 110% of the best snatch) of highly-qualified weightlifters. The kinematic, dynamic and electromyographic characteristics of snatch pulls with 90% of the best snatch correspond to the coordination structure (except for the height of the lift) of the classic snatch. Significant deviation from the optimal technique parameters of a 90% snatch occurs when the snatch pull intensity is increased to 100 and 110%. Frolov concluded that a significant number of lifts with limit weights in snatch pulls, although contributing to increase in strength, will have a negative effect on the coordination structure of the basic competition movement. Consequently, he recommends that an athlete use only 90% weights for snatch pulls when he reaches sporting form and exclude this exercise altogether from one week before competition.

One of the most important factors of managing the training of classified-weightlifters is the optimal number of lifts with the fundamental training weights in one exercise. A. S. Prilepin's (1974) research established that the following number of lifts are optimal:

70% (3-6 repetitions) -- 18 lifts;
80% (2-4 repetitions) -- 15 lifts;
90% (1-2 repetitions) -- 7-10 lifts.

If the number of lifts in one exercise is significantly above or below the optimal, the training effect decreases. A. S. Prelipin recommends the following number of lifts:

70% - no less than 12 and nor more than 24;
80% - no less than 10 and no more than 20;
90% - no less than 4 and no more than 10.

Thus, when planning training loads in one exercise for classified-lifters only one training weight of 70, 80 or 90% is used in each exercise after the basic warmup in each movement. In the competition period classified-lifters should plan 120-140 lifts with 90%, of which 50-60 are in the snatch and 30-40 are in the clean and jerk. With a volume of 570-600 lifts 70% lifts should comprise 23.8%, 80% - 36.8%, 90% - 25.4% and over 90% - 14%.

According to A. D. Ermakov's (1974) research, in 74.3% of the cases the ratio of the volume of the load to the average weight of the barbell was advantageous when the dynamics of these two parameters were unidirectional and in 25.7% of the cases when they were reciprocal. In 61% of the cases there was a coincidence of the largest weekly intensity. Consequently, if this regularity occurs in the loads planned then it is unadvisable for the coach to hasten to change the volume.

When is the largest load in the weekly cycle executed? Data obtained by A. D. Ermakov shows that when there are four-workouts in a week the largest volume day (37.5%) is the second, the first (34.3%) is next, then 25.0% and 3.2%, the third and fourth respectively. A. V. Chernyak's (1978) recommendations can be utilized to construct the weekly training cycles. Based upon a logico-mathematical analysis of training and statistically treated material, the author concluded that the workouts can be set up with standard figures expressing the relative distribution of lifts in percentages. The following distribution is optimal for three workouts in a week: 24, 28 48%; for four workouts - 15, 22, 28, 35% and for five workouts - 13, 15, 15, 27 and 30%.

It is advisable to determine all of the relative parameters in the weekly cycles as percentages of the monthly volume. All the variations of the weekly loads can be constructed utilizing these four figures: 35, 28, 22, 15 which express the quantity of lifts in the micro-cycle as a percentage of the monthly volume. These figures are averages. They can be varied by ± 1.5%.

One can take into consideration not only the athlete's sport achievements but also their growth over a certain period of time, to effectively assess a particular training program. In practice, it becomes necessary to assess the effectiveness of training by comparing two groups of weightlifters of different qualification and weight class. It is of interest to assess the effectiveness of a training cycle in relative units (V. A. Maslenikov, S. G. Filanovsky, 1975). The best total in training at the beginning of the training cycle (r_1) and at the end of it (r_2) are divided by the conventional personal best total in the beginning as well as at the end of the cycle (R_1 and R_2).

The criteria of the sportsman's training cycle effectiveness (K) will be, in the given instance, the difference between the initial and the end results expressed in relative units:

$$K = \left(\frac{r_2}{R_2} - \frac{r_1}{R_1}\right) 100\%,$$

or if the athlete does not change weight class:

$$K = \frac{r_2 - r_1}{R} 100\%.$$

This criteria enables one to assess the effectiveness of training management and the sporting form of weightlifters of different qualification and weight class.

Recently, as is known, the majority of weightlifters train two-three times per day. The workouts are separated by 6-8 hours of rest and regulated such that a larger volume of work is executed than the regular one workout volume. V. M. Volkov's (1977) studies showed that the strength changes up to the same level as occurs in a once-daily large training load. Consequently, two workouts a day are less stressful than one large workout. The first workout consists basically of speed-strength types of special exercises for the snatch and the clean and jerk. The main assistance exercises (squats, pulls, etc.) are for strength and strength endurance.

Twice-daily workouts are usually done during the preparation period and seldom in the competition period. For the most part, alternation of once and twice-daily workouts in the weekly cycle observes an important principle of sport training -- the spasmodicity of the volume and intensity of the loads.

What times are optimal for two workouts per day? Studies by Y. V. Shcherbin and P. M. Mironenko (1980) show that there are fluctuations in a weightlifter's work-capacity during the 24-hour daily cycle. Thus, after recording the electrical activity of the neuro-muscular apparatus over a 24-hour period increases in activity were noted from 12 to 14:00 hours and from 18 to 20:00 hours. An increase in bioelectrical activity is accompanied by a rise in muscle work-capacity. It is necessary to take this fact into consideration when planning two workouts per day.

Strength measurements over a 24-hour period (standing and grip dynamometer, ability to differentiate muscular force and explosive strength of the lower extremities) also indicate that there are two periods during the day when there are rises in strength -- from 11 to 14:00 hours and from 18 to 21:00 hours. Muscular power increases by 10-30% at these times.

The periodic fluctuation in the functional activity of the skeletal muscles significantly affects the development of strength. Y. V. Shcherbin and P. M. Mironenko (1980) noted a greater increase in muscular strength during the periods of rising functional activity of the skeletal musculature (table 5).

Table 5

Increase in Strength at Different Times of the Day

Group	Training Time	Subjects	Increase in Strength (M ± t), %	
			Bench Press	Static Pull
I	11:30-13:00	10	27.7 ± 1.89	13.2 ± 1.02
II	16:00-17:30	10	19.7 ± 2.71	8.6 ± 0.83
III	18:30-20:00	10	24.8 ± 2.25	11.5 ± 1.57

This data enables us to recommend twice-daily workouts from 11 to 14:00 hours (first workout) and from 18 to 21:00 hours (second workout).

Optimization of the volume and intensity of the load, the number of limit lifts and times for twice-daily workouts enables coaches and athletes to manage training effectively; and selectively work on the lagging aspects of preparedness in order to achieve sporting form at the moment of competition.

Means of Methods of Modeling in the Management of Training

One of the real trends in physical education and sport training is the modeling of an athlete's career.
Studies endeavoring to find the means of achieveing high sport

results utilize modeling for studying systems. Solving such tasks is inconceivable without the use of the fundamental theoretical positions of Biology, Mathematics, Physics, Cybernetics, Physiology, Biomechanics and other sciences.

In order to manage training effectively it is necessary to have model characteristics selected as points of orientation for the achievement of planned results. To accomplish this, it is necessary to devise quantitative assessments of the fundamental components of sport mastery and the developmental level of the key systems of the athlete's organism (V. V. Kuznetsov, A. A. Novikov, B. N. Shustin, 1975).

At the present time the models most often used for managing sport training and solving the applied tasks of sport are known as analogs, in Cybernetics. The most important are the integral models which have traits in common with morphological and functional characteristics; their hierachical co-ordination reflects the developmental level and regulation of specific functional qualities and technical abilities (R. E. Motylyanskaya, 1979).

What are these models? The mathematics of gnosiology are based on the fact that models are a form of knowledge. In all of their diversity they serve as a representation of the external world in the minds of people, whether an original form of representation or a means of representation.

The word model signifys a conditional pattern (representation, scheme, description). V. A. Shtoff (1966) gave a classic definition of a model: it is a mental representation or material realization of a system which represents or reproduces an object of investigation, it is able to substitute in such a way that in studying it, new information about this object is obtained. Modeling is understood to be the process of researching an object of knowledge through its models. Having an exclusively interesting character, modeling is a category of gnosiology which is one of man's important means of knowledge in general.

Sports specialists repeatedly point to the necessity of creating "heuristic models of sportsmen", "models of model sportsmen", "models of future athletes", etc. However, bear in mind knowledge of the structure and function of the separate systems of the organism, of the structure of trainability is insufficient and the final construction of such models are scarcely possible. One can only speak of preliminary models consisting of separate indexes -- of the so-called model characteristics. They characterize the fundamental components of models and are brought into correspondance with general block-schemes (V. V. Kuznetsov, A. A. Novikov, 1975).

Theoretically an obligatory condition for management of training is the presence, in the managed system (the coach's), of data on the sportsman's state which he needs to achieve in order to show the planned results. A number of specialists point to the necessity of isolating the models of the basic aspects of preparedness: physical, technical, psychological as well as models of the body's subsystems and their interconnection.

According to V. V. Petrovsky (1978), it is expeditious to isolate several groups of models of which the character and abilities of each, are unequal by comparison: 1) models of competition, 2) models of training influences - exercises, workouts, 3) models of training and its composite parts (yearly cycle, prepatory or competition periods, etc.). It should be pointed out that in all types of modeling, it is necessary to strive to reflect the structural and the functional connections between the composite elements.

V. N. Platanov (1980), believes the effectiveness of mean model characteristics will be sufficient only for training junior athletes and adults who have not yet achieved the pinnacle of sport mastery. Individually worked-out models of preparedness are necessary for sportsmen who have masters of sport international class results or higher. Based on this, in conjunction with the data studied and utilized reflecting the capabilities of distinguished sportsmen, the dynamics of each prospective athlete's results should be studied: his inclinations, adaptive potentials, regularities in the attainment of different components of mastery, interconnection between the factors of sport mastery and sport improvements, etc.

V. N. Platanov showed that constructing individual models for distinguished athletes reduces the large reserves of training management and raises its quality.

We attempted to systematize the model characteristics of the different aspects of a qualified weightlifter's preparedness in different weight classes. Before switching to examining model characteristics let's dwell on a block-scheme model of a sportsman. A preliminary block-scheme model of the strongest athletes, consisting of three levels and prepared by the All-Soviet Scientific-Research Institute of Physical Culture serves as the point of departure (see diagram).

Block-Scheme Model of the
Strongest Athletes

Performance in Competition

Special Physical Preparedness | Technical Preparedness | Tactical Preparedness

Functional Preparedness | Psychological Preparedness | Morphological Preparedness | Age and Sport Stage

The performances of the strongest sportsmen in important competitions form the basis for which one is able to construct "competition models". These are on the first level; characteristics of special, technical and tactical preparedness of the strongest athletes in the sporting form period are on the second level; characteristics of functional and psychological preparedness, morphological peculiarities, age and sport stage of athletes in the period of highest sport achievements are on the third level.

Model Characteristics of Special Physical Preparedness. Examination of the fundamental theoretical positions, which determine the contents of the model characteristics of special physical preparedness are of primary significance for a weight-

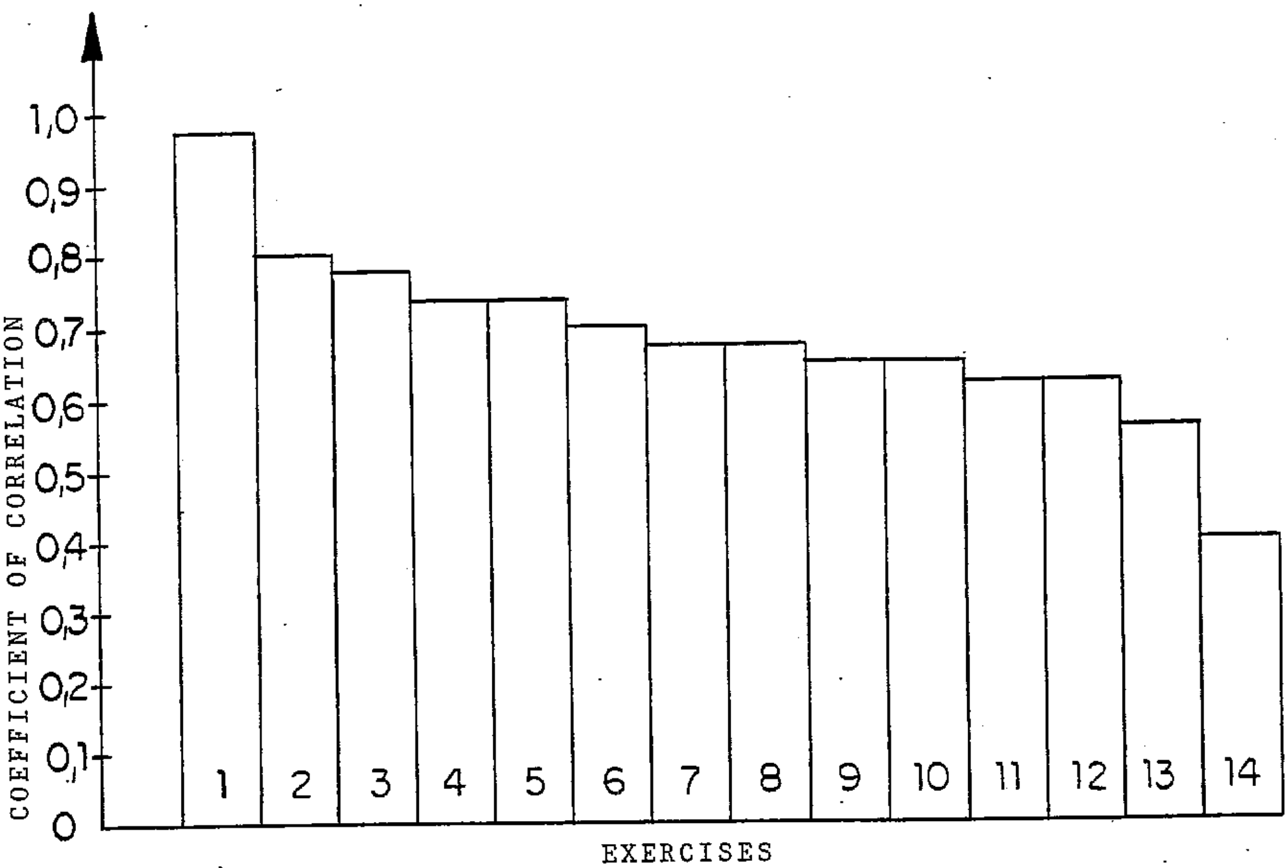
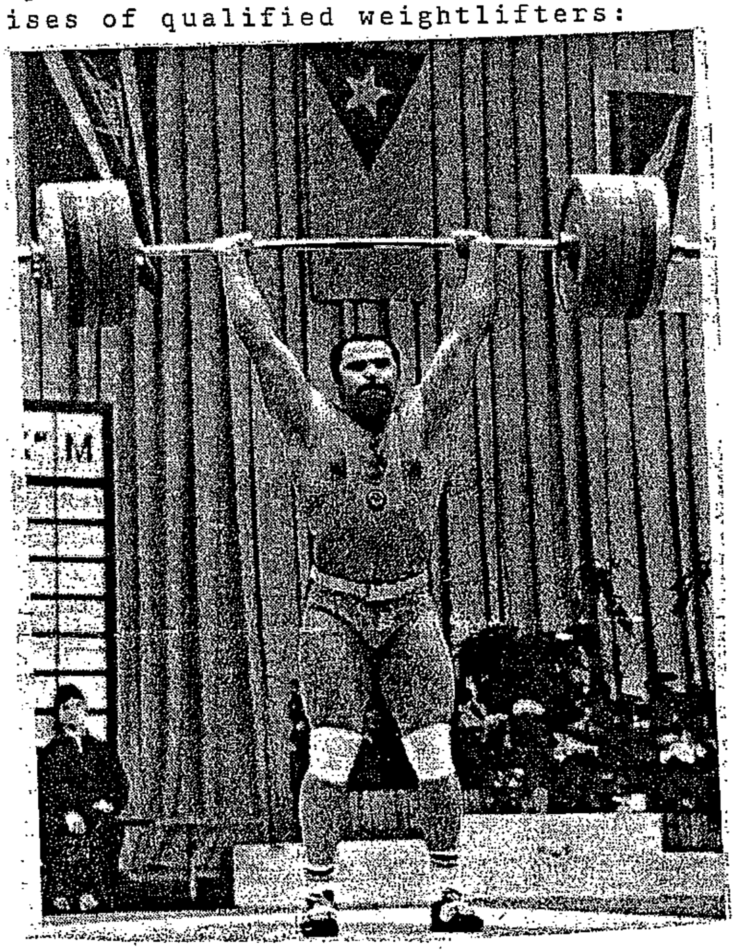


Figure 11. Correlational Inter-dependence between maximum results in the classic and assistance exercises of qualified weightlifters:

1- Power clean
2- Power snatch
3- Clean
4- Overhead squat
5- Clean from the hang
6- Jerk from stands
7- Push-Jerk
8- Front squat
9- Snatch from hang
10- Clean from plinths
11- Snatch from plinths
12- Back squat
13- Seated press
14- Jerk from behind head



lifter's high results.

The best training lifts in the assistance exercises are often utilized for assessment of a weightlifter's special physical preparedness. As is known, they are divided into special and general-developmental exercises. Weightlifting specialists draw-up model characteristics in accordance with these exercise groups. Why are assistance exercises used in drawing-up model characteristics? First, there is a high correlation between the results of the classic and the assistance exercises (figure 11). Second, the majority of assistance exercises are similar in structure to the competition exercises.

In the past, characteristics of maximums were drawn-up for some of the assistance exercises only, without taking into consideration the lifter's qualification or weight class. Now, they have been drawn-up for the majority of assistance exercises and for athletes of different qualification and weight class.

The weightlifting faculty of the KGIFK's research enabled them to draw-up model characteristics of maximums in the assistance exercises for masters of sport (table 6), candidates for master of sport (table 7) and class I athletes (table 8) by weight class. We established the percentage ratio between maximums in the classic and 12 assistance exercises. Special exercises for the snatch (snatch from plinths, snatch from the hang, overhead squats) were correlated to the best snatch, taken as 100%.

Special exercises for the clean and jerk, squats and seated press were correlated to the best clean and jerk, taken as 100%.

In addition, model characteristics of maximums in two special exercises were established with the help of control tests (78 lifters): the power snatch and the power clean. The depth of the half-squat was limited to a knee angle of 70° for determination of maximums in these exercises. This is considered the optimal angle for the "power" exercises.

As the data in tables 6-8 indicates the percentage relationship between results in some assistance exercises varies according to the athlete's qualification, weight class and the type of exercise. The percentage relationship between maximums decreases

Table 1. Dependence between results in the classic and the special-assistance exercises for USSR masters of sport, %

Wt. Class	# Men	Snatch from plinths	Snatch from hang	Overhead squat	Clean	Clean from plinths	Clean from hang	Jerk from stands	Jerk behind head	Push-jerk	Front squat	Back squat	Seated press
52	11	93±8,9	97±6,8	103±14,3	98±9,2	90±11,2	89±6,0	102±2,6	95±6,1	89±6,5	119±5,3	136±7,1	55±5,8
56	12	98±5,0	97±7,0	108±8,5	101±3,4	97±4,1	98±6,9	102±7,8	97±7,8	95±7,6	114±7,5	133±9,2	55±2,5
60	25	94±7,2	97±5,2	107±7,3	101±5,7	92±4,4	92±5,6	103±4,9	90±3,5	89±2,0	113±7,2	131±9,7	55±5,2
67,5	29	95±6,4	96±3,2	107±9,1	100±4,5	95±4,8	94±3,7	102±3,3	100±7,0	90±4,3	113±7,3	131±6,6	56±6,1
75	37	95±7,0	96±5,9	106±6,6	100±5,6	93±5,4	92±5,0	102±5,2	94±9,0	91±5,6	112±5,4	129±6,3	53±4,1
82,5	50	94±6,1	95±6,0	103±8,5	101±3,3	93±5,2	91±5,6	101±5,5	101±7,2	91±4,4	110±6,5	129±8,2	55±6,6
90	33	96±5,9	95±5,0	107±9,7	101±2,9	97±6,0	94±4,5	100±4,9	95±9,4	93±7,2	111±7,2	129±10,2	55±5,0
100	27	93±5,6	95±7,2	100±9,2	100±4,0	94±7,6	93±6,9	100±4,6	95±6,2	90±6,6	108±7,4	128±7,7	57±3,0
110	26	98±5,5	95±7,1	99±6,4	101±2,8	97±5,4	93±4,7	102±5,4	101±7,8	93±5,9	108±7,0	129±8,0	57±5,8
Св.110	10	94±10,0	96±5,4	93±7,4	98±4,0	92±7,1	92±5,1	104±3,7	86±4,2	81±4,7	103±7,7	129±8,9	63±6,4

Table 2. Dependence between results in the classic and the special-assistance exercises for candidates to master of sport, %

Wt. Class	# Men	Snatch from plinths	Snatch from hang	Overhead squat	Clean	Clean from plinths	Clean from hang	Jerk from stands	Jerk behind head	Push-jerk	Front squat	Back squat	Seated press
52	6	100±3,0	100±2,3	116±3,6	102±2,5	96±2,1	97±6,5	105±1,5	100±6,2	99±3,0	112±1,4	131±1,2	53±1,5
56	8	89±3,5	89±4,0	103±9,8	107±5,9	96±3,5	93±2,1	103±3,2	90±5,8	87±4,2	113±6,8	129±7,7	56±3,7
60	10	96±4,6	97±4,4	112±5,7	104±2,2	99±3,9	95±3,4	104±3,5	98±3,7	93±2,2	111±9,4	131±10,0	54±4,1
67,5	12	97±4,6	94±4,6	109±7,7	102±3,2	99±4,0	95±4,7	101±6,0	90±2,5	90±5,6	111±5,5	126±4,4	52±6,1
75	16	94±7,4	94±7,1	104±6,3	101±3,7	92±2,8	90±6,6	101±5,7	97±7,5	90±4,5	110±5,6	128±10,1	56±4,4
82,5	17	93±6,1	95±5,5	109±5,6	101±2,9	95±3,9	93±4,5	103±3,3	103±6,3	93±3,8	111±6,0	128±8,5	57±5,1
90	11	100±5,1	97±4,0	112±6,7	102±2,2	98±4,3	94±4,7	103±5,5	99±9,2	92±5,2	113±4,7	130±3,3	60±4,6
100	10	95±7,2	95±6,2	101±8,5	102±1,3	95±4,8	96±4,3	101±5,8	103±6,0	93±4,8	112±6,6	135±8,2	57±3,7
110	7	92±6,1	92±4,8	97±6,4	103±2,3	98±8,6	91±2,9	96±4,1	100±3,5	93±3,6	116±7,8	132±10,7	54±3,6
Св.110	6	96±7,4	94±6,1	—	100±3,9	99±6,1	91±2,8	99±4,7	—	92±1,6	106±6,9	131±6,7	52±3,7

Table 3. Dependence between results in the classic and the special-assistance exercises for class I athletes, %

Wt. Class	# Men	Snatch from plinths	Snatch from hang	Overhead squat	Clean	Clean from plinths	Clean from hang	Jerk from stands	Jerk behind head	Push-jerk	Front squat	Back squat	Seated press
52	10	93±5,7	93±5,7	115±10,5	101±6,2	96±8,6	94±5,1	104±6,0	88±4,5	89±5,2	106±8,8	125±6,9	55±6,2
56	9	95±5,5	96±1,7	116±7,7	105±4,7	98±7,0	104±2,0	106±3,8	92±6,2	90±4,8	110±9,8	127±4,6	49±2,9
60	11	94±7,0	97±6,1	104±6,3	103±4,2	100±2,3	96±2,1	103±4,4	98±4,3	90±2,2	114±6,9	129±7,8	52±5,5
67,5	14	95±5,6	96±3,2	111±8,7	102±4,3	97±3,4	95±4,7	102±5,3	98±7,3	91±4,5	108±7,3	124±5,5	52±4,3
75	22	97±5,9	92±6,2	106±9,2	102±3,9	96±5,9	93±7,2	100±5,3	101±5,3	91±2,8	110±6,6	129±8,7	53±7,0
82,5	20	96±5,9	95±6,1	102±9,8	102±3,1	96±5,7	93±4,0	102±5,9	99±8,8	91±4,0	110±6,1	131±9,2	53±6,1
90	15	92±5,9	91±7,1	108±10,8	101±2,5	94±3,5	92±4,3	102±4,5	93±10,8	92±5,6	109±7,0	126±4,7	58±4,5
100	10	94±4,9	94±5,8	103±3,6	103±3,5	99±7,0	97±1,2	102±5,9	98±4,5	93±3,6	109±1,5	124±4,9	59±1,7
110	7	97±7,0	93±2,5	98±6,2	104±1,4	97±3,7	91±4,0	100±5,0	94±9,6	92±4,1	112±5,0	130±9,1	58±3,4
Св.110	5	96±7,4	92±4,9	—	98±8,2	91±6,9	91±3,4	100±4,6	—	90±2,0	107±6,2	127±6,4	—

with the increase in bodyweight for some assistance exercises. The figures for the snatch from the hang are from 99-95% for masters of sport (correlation between percentage ratio and bodyweight was r=-0.71); overhead squat, from 110 to 97% (r=-0.71); front squat, from 116 to 108% (r=-0.73); back squat, from 135 to 127% (r=-0.86). For candidates to master of sport: overhead squat, from 110 to 97% (r=-0.70). For class I athletes: snatch from the hang, from 98 to 92% (r=-0.52); overhead squat, from 113 to 98% (r=-0.96), back squat, from 129 to 124% (r=-0.61).

The percentage ratio between seated press maximum rises as the athlete's bodyweight increases: for masters of sport - from 52 to 63% (r=0.71), for candidates to master of sport - from 53 to 58% (r=0.33) and for class I athletes - from 50 to 59% (r=0.75).

Consequently, one can conclude that it is inappropriate to establish equivalent model characteristics in the aforementioned assistance exrecises for athletes of one qualification and different weight class. How do the percentage ratios change between classic and assistance exercise maximums for lifters of different qualification, but in the same weight class? The results of middleweights are compared in table 9.

It can be seen from the data presented in this table that the difference in percentage ratios between the results in the classic and some assistance exercises for masters of sport international class (MSIC) and class II athletes is statistically reliable. This difference appears in the following exercises: snatch from plinths (100% for MSIC versus 93% for class II), jerk from behind the neck, from stands (103 and 95% respectively) and in the push-jerk (97 and 92% respectively). There was no significant difference for the other exercises.

Control tests have established that the ratio between the snatch and the power snatch is a mean of 80.9% for masters of sport in different weight classes, 80% for candidates to master of sport and 79.6% for class I (the differences are not statistically significant). The ratios between the clean and the power clean are 83.4, 81.8 and 80.6% respectively (the difference is

Table 9

Model Maximums in Assistance Exercises ($m \pm t$) for Middleweights of Different Qualification, %

Qualification	Snatch from Plinths	Snatch from Hang	Overhead Squats	Clean	Clean from Plinths	Clean from Hang	Jerk from Stands	Jerk Behind Neck	Push-Jerk	Front Squat	Back Squat	Seated Press
IMS	100±0.8	98±1.8	111±2.6	103±0.6	97±1.4	95±1.5	103±1.6	103±1.1	97±1.8	111±1.4	123±2.1	58±0.4
MS	96±0.5	97±0.2	106±0.5	101±0.2	96±0.3	94±0.3	103±0.7	101±0.5	94±0.5	112±0.5	128±0.6	55±0.3
Cand. to MS	96±1.4	96±0.5	104±1.1	102±0.6	97±0.5	94±0.3	104±0.3	101±0.3	92±0.8	110±0.9	128±1.0	55±0.9
Class I	94±0.6	94±0.6	105±1.0	102±0.6	96±0.9	97±0.6	101±0.6	99±0.8	91±0.5	109±1.0	128±1.6	56±0.5
Class II	93±1.0	97±1.4	109±1.9	103±1.1	98±1.2	96±1.1	103±1.5	95±1.4	92±0.8	106±2.8	129±3.2	59±1.2

statistically insignificant). Consequently, one can assume that it is unnecessary to draw-up model characteristics in each weight class separately.

It is impossible to consider the preliminary research in this area as definitive. In the future it will be necessary to analyze the results of a large number of athletes in each weight class with the common requirement for everyone -- depth of the half-squat should not exceed a knee angle of 70°.

The most completely studied question in the special weightlifting literature concerns the ratio between the back and front squat with the snatch and the clean and jerk. A. V. Chernyak (1970) established, that as sport mastery rises (from novice to master of sport international class) the snatch (of athletes in different weight classes) is equal to a mean of 62% of the squat and the clean and jerk is a mean of 82% of the squat (the 52 and over 110 kg classes were excluded from the calculations).

Later, A. T. Ivanov (1976) established several more precise regularities of the squat to clean and jerk ratio. It is not very easy to establish this ratio by weight class. The lightest and heaviest weightlifters have the highest squats. In other words, according to the increase or decrease in bodyweight, relative to the middleweight and lightheavyweight classes, the squat (as a percentage of the maximal clean and jerk) increases.

Maximum Squat (as percentage of the Clean and Jerk
for MS and MSIC)[A. T. Ivanov, 1976]:

Weight Class	# Athletes	Squat (M ± 8)
52	26	139.6 ± 7.5
56	23	138.5 ± 7.4
60	28	137.4 ± 5.9
67.5	34	130.3 ± 6.3
75	32	127.0 ± 5.2
82.5	21	127.0 ± 5.1
90	27	134.0 ± 4.8
110	20	139.2 ± 5.5

For masters of sport the clean and jerk to back squat ratio changes with the increase in bodyweight (see table 6) from 135% in the lightest weight class to 127% in the second heavyweight. For example, according to our data, the clean and jerk to squat ratio is maximum in the lightest weight class, then decreases up to the middleweight class and further stabilizes in the heavyweight classes (from 82.5 to 110 and above).

According to A. T. Ivanov the graph of squat to clean and jerk ratio yields a normal distribution. Unfortunately, the author did not study two weight classes (110 and over 110 kg) and therefore, could not fully characterize the dynamics of the ratio between the clean and jerk and the squat.

Why do the light-weights have higher relative squats than the heavy-weights? In our opinion, this can be explained by the fact that they lift an apparatus which is 2.5 times and more than their bodyweight. And, to do this it is necessary to have strong legs and the frequent loss of bodyweight for competitions affects these muscles. Therefore, it is necessary for the light-weights to have a "margin of error" in leg strength, which enables them to successfully cope with maximal weights.

How can one utilize the model characteristics in practice? This is illustrated with the following example. Suppose it is necessary to determine the special physical preparedness of a lightheavyweight master of sport in the snatch (his best snatch in competition is 130 kg). One needs to do the following calculations.

1. Determine the sportsman's maximal training lifts in the special snatch exercises executed in the last 2-3 months before the competition. The results are placed in table 10.

Table 10

Exercise	Results		
	Maximum, Kg	Model, %	Calculated with Formula, Kg
Power Snatch	115	81	142.0
Snatch from Plinths	125	95	131.5
Snatch from Hang	130	96	135.4
Overhead Squat	145	103	140.7

2. The model characteristics for lightheavyweight masters of sport are in table 6. These results are placed in table 10.

3. Calculate the expected results with the following formula:

$$Se = \frac{S_{max} \cdot 100\%}{MR\%},$$

where Se - expected result in the snatch, S_{max} - maximum in the special exercise, MR - model of maximal result in the special exercise. The results obtained are in table 10.

4. Calculate the mean snatch result (from the four snatch exercises) with this formula:

$$Se = \frac{142.0 + 131.5 + 135.4 + 140.7}{4} = 137.4$$

Thus, the given athlete can (with good psychological preparedness) snatch 137.5 kg in competition, which is 7.5 kg over his previous best. Consequently, the weightlifter's level of preparedness for competition can be considered sufficiently high. If the results of control assessments are added to this, then one can judge with great precision the first snatch attempt in competition.

Preparedness for the clean and jerk can be determined in an analogous fashion: use maximums in 10 assistance exercises (including the power clean) and using model characteristics calculate according to the aforementioned method. If the athlete does not know his maximum in some of the assistance exercises then the calculations are done without them. This reduces the preciseness of the assessment.

With the use of model characteristics one can determine a weightlifter's degree of strength realization at a given stage of sport perfectioning. In order to do this it is necessary to compare the competition results in the snatch and the clean and jerk to the expected with the formula of results in these exercises. For example the best competition snatch is 130 kg and the athlete's calculated preparedness is 140 kg. Consequently, the athlete did not realize his strength capability. In this case he needs to raise the level of technical preparedness in the snatch.

If the competition and the expected (according to the formula) results coincide, then the degree of strength realization is considered sufficiently high. One can use the control norms of the assistance exercises in the forthcoming stage of training for each athlete to plan for the upcoming competition. The following formula is used:

$$Se = \frac{S_{max} \cdot MR\%}{100\%} .$$

The calculations are repeated to determine the results of each assistance exercise. Our method of assessing special-physical preparedness of weightlifters can be an additional criterion for determining when weightlifters achieve sporting form. By revealing the lagging results in the assistance exercises, the coach can plan the athlete's training for the next training period such that he can reach the model maximums in the assistance exercises over a certain period of time. The measures enumerated are a part of training management.

Model Characteristics of Technical Preparedness. These are drawn-up from basically three sides: a) the rational movement of the apparatus; b) the rational movement of the athlete; c) the movement of the athlete-barbell system. Photographic data has been used for model characteristics of technical preparedness. At the present time, video-recorders, goniographs, cyclographs and other more sophisticated methods of recording movement are used.

Let's dwell briefly on the most progressive method of data collection -- the goniometer. A. A. Lukashev (1972) devised a new complex method of assessing technical masterery. He devised a new phasic scheme for the biathlon exercises. B. A. Podlivayev (1974) and V. I. Frolov (1976-1978) corroborated the appropriateness of using this scheme in practice. The principal distinction between this scheme and other earlier schemes amounts to: L. N. Sokolov (1960, 1965), R. A. Roman (1965, 1974) and other authors put the moving of the knees under the bar in the first phase of the pull and the final extension of the body's links in the second phase ("explosion"). A. A. Lukashev and V. I. Frolov combined the moving of the knees under and the final extension of the lower extremities into one period -- the "explosion" and divided it into two phases: the moving of the knees under and the final acceleration. We took into consideration these divisions of the movement into phases for the allotment of model characteristics of technical preparedness.

Although technique can be individualized, specialists have drawn-up optimal model characteristics of the different phases and the amplitude of movement in the joints during the execution of the classic and assistance exercises. For example, V. I. Frolov (1977) proposed model characteristics for the optimal duration of the phases: preliminary acceleration (2nd), moving of the knees under (3rd), final acceleration (4th), speed and height of the lift of highly-qualified weightlifters executing the snatch (table 11). They also determined the optimal angles of the ankle, knee and hip joints at the most critical -- "bordering" -- instants of the movement (table 12).

Table 11

Optimal Duration of Snatch Phases, Speed and Height of the Lift, % of Maximum

Phase	Duration of Snatch Phase, sec.	Speed of the Lift	Height of the Lift, cm
2nd	0.40 - 0.50	60 - 70	30 - 34
3rd	0.11 - 0.14	65 - 80	42 - 48
4th	0.16 - 0.20	100	72 - 78

Table 12

Optimal Ankle, Knee and Hip Angles at the Bordering Phases of the Snatch, Degrees

Borders of Phases	Angles		
	Ankle Joints	Knee Joints	Hip Joints
2-3	85 - 90	135 - 150	90 - 100
3-4	60 - 75	115 - 125	110 - 125
4-5	115 - 125	165 - 170	175 - 180

Initially, model characteristics were drawn-up taking into consideration only sport qualification, then weight class, height and morpho-functional indices were included.

Model characteristics of qualified-weightlifters' technical preparedness were drawn-up by the KGIFK Weightlifting Department (V. G. Oleshko, 1979). Goniographic data from 78 sportsmen who executed the snatch and the clean during the competition period was collected; weights were at least 90% of maximum. The subjects were masters of sport, candidates for master and class I.

Analysis of the data showed that only masters of sport had a significant correlation between goniographic indices and the snatch and the clean results. The non-significant intercorrelation of lesser-qualified weightlifters can be explained by the fact that their technique is unstable and their movements are not economical. Sportsmen of higher qualification possess greater stability in the execution of the exercises which influenced the end results of the research. An interdependence between sport results and the basic parameters of technical preparedness of masters of sport (time of execution of the five phases of the snatch, time of final acceleration phase of the snatch and the clean) has been established. However, weight-height indices correlate with time of execution of the final acceleration phase in the clean and knee joint angles in the snatch and the clean.

The model characteristics attributed to the following goniographic parameters reflect the level of technical preparedness ($M \pm t$).

1. Length of time to execute the five phases of the snatch.* 1.37 ± 0.02 sec.

* Not including the time to recover from the squat position.

2. Length of the final acceleration phase in the snatch and the clean for three groups of athletes:

52 - 67.5 kg	0.16 ± 0.004 sec.
75 - 82.5 kg	0.14 ± 0.004 sec.
90 - 110 kg	0.13 ± 0.003 sec.

3. Knee Extension in the snatch (column I) and the clean (column II) for athletes in different weight classes:

52 - 67.5 kg	172.1 ± 1.2°	165.2 ± 0.7°
75 - 82.5 kg	163.1 ± 1.0°	160.5 ± 0.7°
90 - 110 kg	160.0 ± 1.0°	157.4 ± 1.4°

Our research on weightlifters of different qualification and weight class is in agreement with the technique parameters established earlier by V. I. Frolov. We can conclude that despite individual variations in the technical execution of the exercises, the essential parameters of technical preparedness are within the determined ranges for qualification and weight class. Therefore, the model characteristics of technical mastery is one of the fundamental requirements in managing the training of athletes. According to A. V. Chernyak's data (1978), the technical preparedness of weightlifters can be assessed according to following criteria:

$$C_s = I_s \cdot (100 - h_{sp})$$

$$C_{c\&j} = I_{c\&j} \cdot (100 - h_{cp}) \ ,$$

where C_s - criterion of technical mastery in the snatch, I_s - general index of strength realization in the snatch, h_{sp} - relative height of the lift in the snatch pull, $C_{c\&j}$ - criterion of technical mastery in the clean and jerk, $I_{c\&j}$ - general index of strength realization in the clean, h_{cp} - relative height of the lift in the clean pull.

The general index of strength realization in the snatch (I_s) is determined according to the following formula:

$$I_s = \frac{D_s^2}{D_{sq} + D_{sp}}$$

The general index of strength realization in the clean is determined according to this formula:

$$I_{c\&j} = \frac{D_{c\&j}^2}{D_{sq} + D_{sp}} \ .$$

The relative height of the lift in the snatch pull is

$\frac{H_{sp}}{h} \cdot 100$, and the relative height of the clean pull is

$\frac{H_{cp}}{h} \cdot 100$, where H_{sp} and H_{cp} - are the absolute height of the lift in the snatch and clean pull respectively (CM), and h is the athlete's height (CM).

Consequently, in order to calculate the criterion of technical mastery with A. V. Chernyak's formula it is necessary to determine: a) the best snatch, clean and jerk, squat and static pull (dynamometer, Ed.); b) the height of the lift in the snatch and the clean pull; c) the athlete's height.

The criterion of technical mastery has a tendency to increase along with the rise in sport qualification. The following quantitative criterion of technique, as suggested by A. V. Chernyak, can be attributed to model characteristics:

	Snatch Conditional Units	Clean Conditional Units
Lower classified athletes	7 - 10	19 - 22
Higher classified athletes	10 - 13	22 - 25
Highly-qualified weightlifters	13 - 16	25 - 28

It is necessary to note, that, at the present time, the chief model characteristics for individual athletes (which are appropriate for highly-qualified athletes) or groups are drawn-up without taking into consideration weight class or height data. Research on model characteristics of the technical preparedness of athletes in different weight classes is clearly insufficient. Serious research in this area still needs to be done.

Model Characteristics of Morphological Indicators. Morphological indicators are found on the third level of the block-scheme model. It is necessary to take into consideration additional indicators: age, stage of training, height, weight and body area, for managing the training of weightlifters. In thier works, T. A. Yenilin (1966), A. I. Mulchin (1966, 1972), Y. M. Shanenkov (1975) and M. B. Starodubtsev (1976) cite models of weight-height indices and other body parameters in accordance with qualification and weight class.

In weightlifting, a significant rejuvenation has been observed in recent years. 18-20 year old lifters have become world record holders, World and Olympic champions. Y. M. Shanenkov (1978) made a comparative analysis of the ages of lifters who took part in the XX and XXI Olympic Games. We consider this to be a model of age characteristics of place winners and Olympic Champions (table 13).

The mean ages of the lifters who participated in the 1972 and 1976 Olympic Games were 27.1 and 26.6 years respectively. The mean age was 26.1 years at the XXII Olympiad. The champions and medalists at this Olympics were two years younger (24.7 and 24.2 versus 26.3 and 26.7) than those at the 1972 games. Consequently, one can say there has been some rejuvenation of weightlifters. Nevertheless, the majority of weightlifters achieve record results at a mature age. A close intercorrelation has been observed between a weightlifter's age, stage of training and weight class.

High results are not connected with the age at which an athlete began training, but are dependent upon the stage of sport training. The highest rate of improvement occurs in the first year of training, it subsequently decreases and after 12-16 years of training improvement ceases. The most rapid improvement lasts for a period of 8 years.

V. S. Kopysov and P. A. Poletayev's (1979) analysis of training and competition showed that a weightlifter's rate of improvement varies according to weight class (figure 12). Athletes, who are at the peak of their careers, in the middle and heavyweight classes have significantly lesser rates of improvement than athletes in the light-weight classes. However, their subsequent improvement begins to progress significantly faster and they can continue to improve significantly over a longer period of time. Consider this, it is necessary to plan for a period of maximal realization of sport achievements at the following dates: at the 5-7 years of training for 52-60 kg athletes, at 6-8 years for 67.5-82.5 kg and at 8-10 years for 90-over 110 kg. It is necessary for coaches to orient athletes to achieve high results at such an age and stage of training which practice has shown to be optimal.

It is known, that height and weight are to a significant degree dependent upon age. Men become bigger and heavier with age. Besides this, each weightlifting class has its own height limitations. Specialists drew-up model height characteristics

Table 13

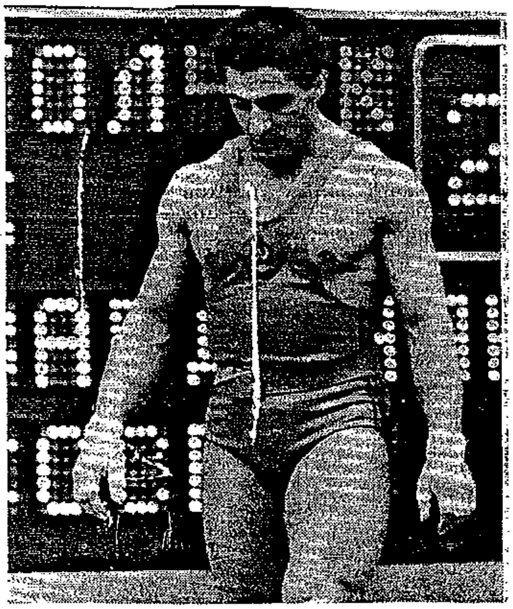
Age Model of Olympic Participants

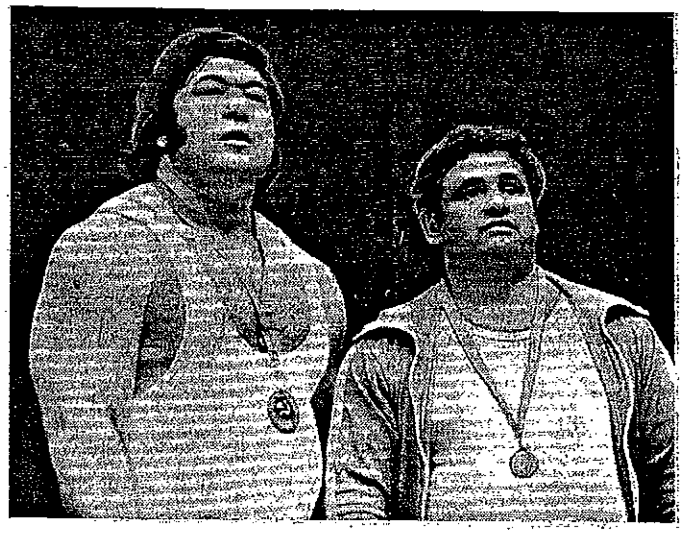
Weight Class, Kg	1972			1976			1980		
	1+	2++	3+++	1	2	3	1	2	3
52	31	27.7	28.0	25	27.3	27.5	27	24.6	25.0
56	34	30.0	27.2	28	26.0	27.0	22	22.0	23.7
60	24	28.7	28.1	24	26.0	26.6	26	24.0	25.8
67.5	23	24.7	25.6	30	29.3	26.6	22	20.6	26.4
75	22	30.3	26.3	20	23.3	24.5	20	22.0	24.5
82.5	24	26.7	27.8	29.5	25.7	26.8	24	24.3	27.3
90	21	23.3	26.2	29	25.7	28.3	29	23.3	25.6
100	-	-	-	-	-	-	23	27.0	27.4
110	28	24.3	26.7	20	22.3	26.2	24	25.6	27.7
ov.110	30	24.3	28.1	34	29.7	26.3	30	28.6	27.6
Mean	26.3	26.7	27.1	25.5	26.0	26.6	24.7	24.2	26.1

+ - champions

++ - medalists

+++ - all participants





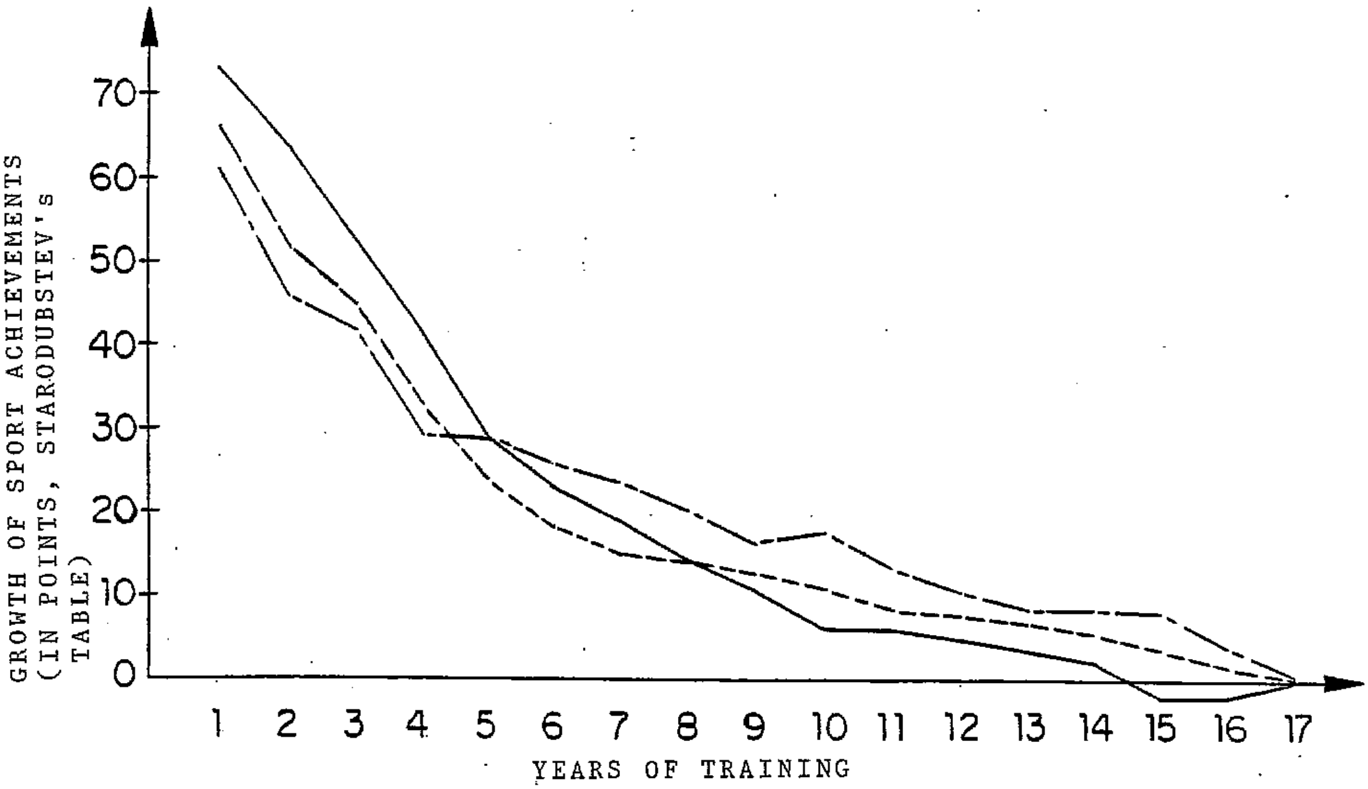


Figure 12. Rate of increase in sport achievements of 126 of the strongest weightlifters in the USSR: Continuous line- 52-60kg weight classes; broken line- 67.5-82.5kg weight classes; broken line with dots- 90-over 110kg classes (B.S. Kopysov, P.A. Polatayev, 1979).

from the 1980 Olympics:

Weight Class, Kg	Athletes Height, Cm
52	up to 146
56	149 ± 2
60	154 ± 2
67.5	160 ± 2
75	164 ± 2
82.5	168 ± 2
90	171 ± 2
100	174 ± 2
110	177 ± 2
over 110	186 ± 5

As is known, athletes of different sport qualifications are not of the same height. A negative correlation is observed here: within a given weight class, the higher a sportsman's qualification, the shorter his height. A. V. Chernyak (1978) drew-up model characteristics of height indices of lifters of different qualification and weight class (table 14).

A. I. Mulchin's (1972) analysis of body dimensions revealed the great disparity between a lifter's maximum and minimum anthropometric indices in all weight classes. Within the confines of one weight class, one can find athletes of unequal height and in another -- athletes who are of the same height but have different leg, arm and torso lengths, width of shoulders and bodyweight.

A. I. Mulchin (1972) drew-up a classification table of body-part dimensions in three weight catagories. These can be considered model characteristics. A. I. Mulchin called athletes with long upper and lower extremities and a relatively short and wide torso -- dolichomorphs; mesomorphs are those with proportional torso-extremity ratios, and athletes with short upper and lower extremities and a relatively narrow, long torso -- brachiomorphs.

The data in table 15 shows that, the taller the weightlifter, of any body type, the greater relative length of the

Table 14

Model of Height Indices

Qualification	Range	Weight Class, Kg								
		52	56	60	67.5	75	82.5	90	110	ov. 10
Novice	Minimum	153	158	163	168	174	179	181	182	–
Class III	Maximum	158	163	168	173	179	184	186	187	–
Class II - I	Minimum	150	155	160	165	170	175	177	178	–
	Maximum	155	160	165	170	175	180	183	183	–
CMS - MS	Minimum	148	151	157	162	166	170	174	178	–
	Maximum	152	156	162	167	171	175	179	183	–
MS - MSIC	Minimum	144	148	155	159	163	167	171	176	183
	Maximum	146	150	157	161	165	169	173	178	188
World Record	Minimum	144	148	154	159	163	167	171	176	183
Holders	Maximum	145	149	155	160	164	168	172	177	189

torso and the shorter relative length of the extremities. With respect to this, athletes who are of different body structure have different technique parameters in the different periods of the classic exercises.

Table 15

Mean Body Part Dimensions of Lifters in Three Weight Groups (% of Height)

Weight Class	Type of Body Structure	Height	Shoulder Width	Pelvis Width	Leg Length	Arm Length
Light	Dolichomorph	29.0	23.1	16.4	55.5	45.8
	Mesomorph	31.0	24.1	17.8	53.3	44.0
	Brachiomorph	33.0	25.1	19.2	51.1	42.2
Middle	Dolichomorph	29.4	22.9	16.0	55.0	45.3
	Mesomorph	31.5	23.8	16.8	52.9	43.8
	Brachiomorph	33.3	24.7	17.6	50.8	42.3
Heavy	Dolichomorph	29.8	22.9	16.1	54.2	45.1
	Mesomorph	31.5	23.8	19.9	52.1	43.6
	Brachiomorph	33.6	24.7	17.7	50.0	42.1

M. K. Kazakov (1975) recommends the use of an athlete's physical development indices (table 16) for morphological control. These can be considered model characteristics.

KGIFK weightlifting faculty member K. V. Tkachenko (1979) researched model characteristics of junior weightlifters. Along with assessment of physical and technical preparedness, morphological, psychological and functional indices of weightlifters in 13-14, 15-16, and 17-18 year old age groups were analyzed. The morpho-functional indices obtained by K. V. Tkachenko are presented in table 17.

Table 16

Model Characteristics of Lifters' (age 21-36 years)
Physical Development

Index	Weight Class, Kg							
	52	56	60	67.5	75	82.5	90	110
Height, cm	155.6	157.7	159.8	164.1	168.7	172.8	175.1	178.4
Weight, kg	53.7	57.9	61.3	67.9	75.2	81.8	89.2	101.9
Shoulder Circum.	87.9	90.3	93.0	96.4	99.4	102.3	105.8	110.7
Vit. Cap., ml	3692.4	3999.6	4061.0	4085.3	4706.5	4619.5	5155.6	5725.0
Grip Strength Right, Kg	47.8	49.9	50.5	55.7	58.9	62.3	67.3	74.6
Grip Strength Left, Kg	43.8	45.8	47.7	51.6	57.6	58.4	60.3	69.4

Table 17

Morpho-functional Indices of Junior Weightlifters ($M \pm \delta$)

Index	Age, years			
	15-16	17-18	19-20	over 19
Height, cm	174.6±1.2	173.8±1.8	171.3±1.5	168.4±2.2
Bodyweight, kg	68.8±1.6	75.9±1.5	81.9±3.1	83.3±3.8
Fat Cont., %	13.9±0.5	13.1±0.8	12.8±0.6	10.6±0.5
Active Muscle Mass Index, units	1.11±0.03	1.24±0.02	1.42±0.02	1.54±0.03
Heart Rhythm, %	168.1±6.9	81.2±2.3	-	10:.3±6.7
Area of True Adjust., units	-	63.7±19.9	75.1±6.8	74.1±6.0
Variable Pulse, units	0.30±0.18	0.43±0.13	0.41±0.2	0.36±-.23

This same author used calipers (M ± beta) to determine percent body-fat of masters of sport and masters of sport international class (n = 83):

Weight Class	% Fat	Weight Class	% Fat
52	11.1±1.1	82.5	10.6±1.4
56	9.3±0.7	90	11.8±1.7
60	9.6±0.9	100	12.6±1.4
67.5	9.9±1.0	110	13.3±2.1
75	11.2±1.2	over 110	16.8±1.8

It has been established that sub-cutical fat layer increases with increasing weight class. The largest percentage of fat is on the stomach and back -- the least is on the forearms and shoulders. Percent body-fat varies 3-4% depending upon the period of preparation for one and the same lifter. Percent body-fat is lowest during the state of sporting form.

Systematic control of body-fat enables one to prognose sport achievements, determine a rational sojourn in a given weight class and objectively assess an athlete's preparedness for a concrete competition.

Model Characteristics of Functional Preparedness. It is necessary that the body's key systems -- the cardiovascular, respiratory and circulatory systems and that the neuro-muscular, motor, visual, vestibular and auditory apparatuses be at a high level of functioning in order to achieve high results in weightlifting.

We devised a method of pedagogical control, for determining the functional state of the neuro-muscular apparatus. It consists of the following tests: maximal movement tempo of small amplitude (tapping test); motor reaction time and speed of a brief movement (recorded with a "sequential reaction gauge"); maximal grip strength; ability to differentiate muscular effort; explosive leg strength and muscle-joint sensitivity during a movement (a standing long jump was executed to a certain amplitude, blindfolded).

The aforementioned control tests were administered to 96 weightlifters who were in different weight classes. The tests were done before training (before the warmup), twice in the micro-cycle at the beginning of the competition period (4th week) and from 3, 2, and 1 week before competition and one day before the competition (tables 18 and 19). There was a significant correlation between the dynamometer grip strength and biathlon results in the competition period. This correlation was 0.70 for masters of sport, 0.60 for candidates to master of sport and 0.89 for class I athletes. There was also a correlation between grip strength and weight class ($r = 0.71$, $r = 0.71$ and $r = 0.56$ respectively). The other neuro-muscular indicators had large variations.

Table 18

Grip Strength Dynamics of Weightlifters of Different Sport Classification (M±t), Kg

Qualification	Base Index	Mean in Contest Period	One Day Before Competition	
			Successful Competition	Unsuccessful Competition
MS	63.3±1.6	65.2±1.7	65.7±2.6	63.2±5.2
CMS	59.1±2.5	61.6±2.8	62.0±4.5	59.5±4.5
Class I	55.1±1.5	57.5±1.8	58.6±2.7	56.1±5.2
Mean Data	60.1±1.0	62.2±1.1	62.6±1.8	62.2±2.7

Table 19

Grip Strength Dynamics of Weightlifters in Different Weight Classes (M±t), Kg

Wt. Class, Kg	Base Index	Avg. Comp. Period	One Day Before Competition
52 - 67.5	51.1±1.0	52.2±1.1	52.8±3.5
75 - 82.5	61.3±1.3	64.6±1.4	65.8±2.4
90 - 110	72.3±1.9	74.1±1.9	76.8±2.1

When one is determining maximum movement tempo, differentiation of muscular force and muscle-joint sense the absolute results of these tests are not the most informative -- the variation is. The less variation in test results during the competition period, the higher the sportsman's trainability.

According to V. A. Geselyevitch (1976), A. Ts. Puni (1977) and other authors, the stability of psychomotor functions and a decrease in the speed of the restoration processes characterize a weightlifter's sporting form. Consequently, one can judge this immediately from the results of these tests.

Explosive leg strength which characterizes the sportsman's speed-strength and is of the first order of importance for the execution of the classic exercises, is of special interest. Abalakov's device, which consists of a centimeter table and holder, is used for this test. The method of measuing a vertical jump is as follows: one end of a centimeter tape is attached to the athlete's waist, the other end is put in the holder. The holder is fastened to the floor such that inertial tension in the tape will not affect the measurements. The subject executes a powerful jump upward after a preliminary half-squat. The height is fixed at the edge of the holder.

Can vertical jump data be utilized as model characteristics of the explosive leg strength of weightlifters in different weight classes but of the same sport qualification? We examined the correlation between vertical jump results and sport achievements. The data obtained on this question is inconclusive. Thus, according to M. P. Mikhailyuk (1971) there is a correlation of 0.71 between the vertical jump and the snatch and 0.70 between the clean and jerk and the vertical jump. A. V. Chernyak (1970) and R. A. Roman (1971) found a correlation of 0.88 between the snatch and the vertical jump and 0.73 between the clean and the vertical jump. According to A. N. Vorobyev's data (1977), the mean correlations between the vertical jump and the snatch and the clean and jerk are 0.37 and 0.34 respectively.

We obtained a correlation of 0.34 between the vertical jump and the biathlon total. Consequently, our data agrees with A. N. Vorobyev's results. It is known that vertical jump results increase with the rise in sports qualification. Model characteristics of the vertical jump of weightlifters of different qualification are presented (A. N. Vorobyev's data, 1977).

Qualification	# Athletes	Mean Index, cm
Novice	15	57
Class III	14	58
Class II	11	65
Class I	12	68
MC	13	72
MSIC	18	85

Research by V. F. Kim and M. S. Khlistov (1978) showed there are essential differences in the vertical jump results of weightlifters who are of the same qualification. This indicates it is necessary to try to develop explosive leg strength individually. Nevertheless, the authors believe vertical jump results can serve as control norms for evaluating explosive leg strength of sportsmen of different qualification.

One can assume, hypothetically, that in one sport qualification the vertical jumps are different according to the weight classes. Consequently, it is necessary to take bodyweight into consideration when determining model characteristics.

We studied the vertical jumps of 98 masters of sport, in different weight classes, during the competition period. The testing was done three times during the microcycle, before training (before the warm-up) at the beginning, middle and end of the competition period. Analysis of the data showed that athletes in the 75-90 kg range have the highest vertical jumps, and as bodyweight increases or decreases, vertical jump height decreases (figure 13). The vertical jump of the masters of sport in these groups varied, on the average, from 63 (60 kg class) to 74 cm (90 kg class). The difference between the maximum and minimum is 11 cm ($p < 0.05$).

Why do the athletes in the middle weight classes (75-90 kg) have the highest vertical jumps and why does height decrease with the increase or decrease in sportsmen's bodyweights?

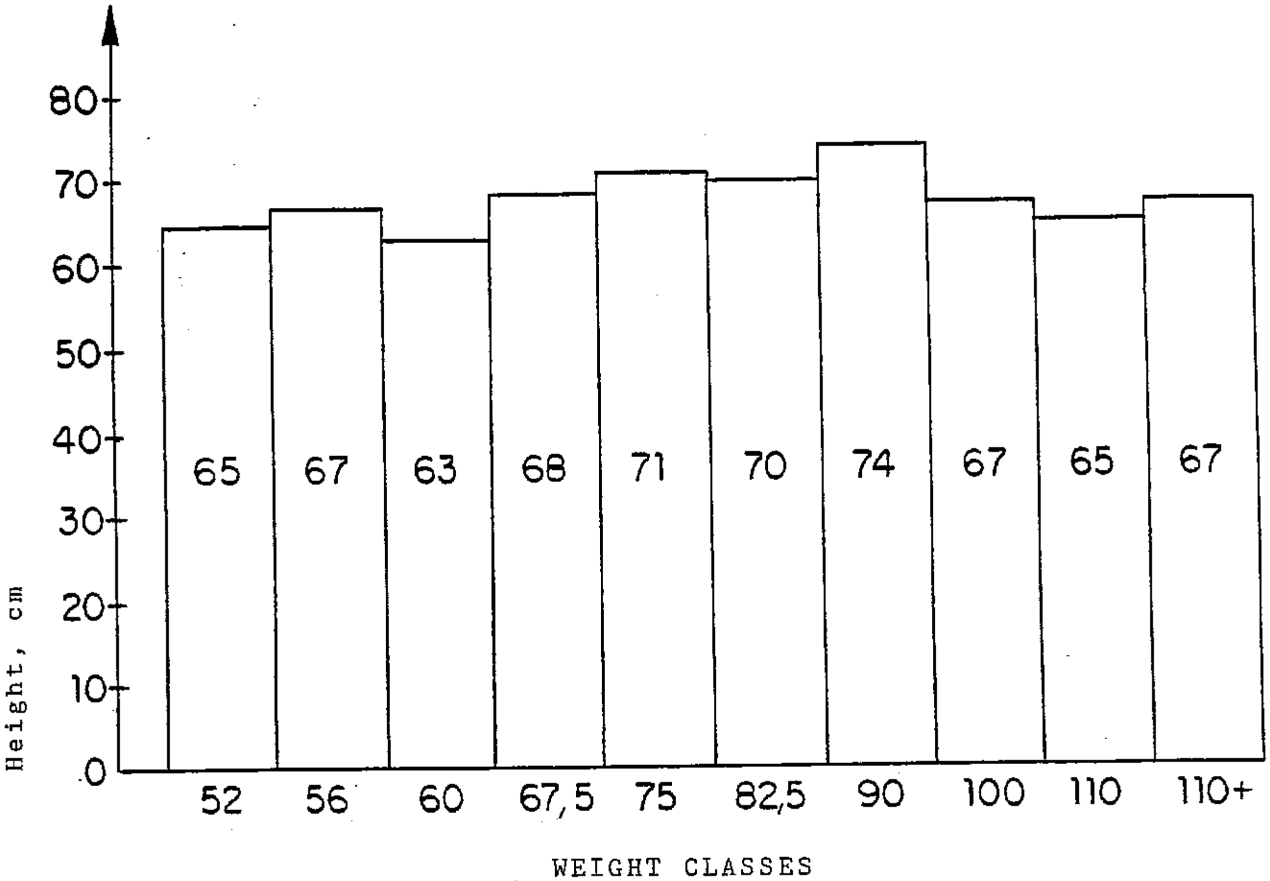
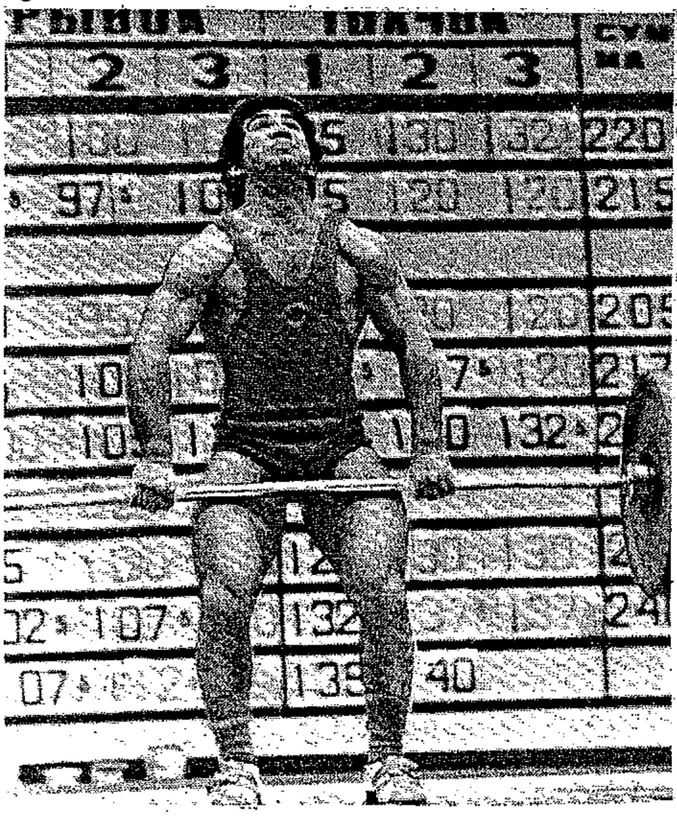


Figure 13. Vertical Jump heights of USSR Masters of Sport



The answer to this question can be determined only by the intercorrelation between sport mastery and the height of the jump. We utilized O. A. Sukhanov's (1967) formula for this purpose. The approximate expenditure of muscular force relative to the force of gravity, (depending upon the athlete's bodyweight) is taken into account:

$$M = \frac{Rt + 2}{2(0.56 - \frac{B-60}{900})},$$

where M - is the index of mastery; Rt - relative biathlon total (or the best snatch and the best clean and jerk results) to bodyweight; 0.56 - portion of muscle weight of weightlifters; 60 - athlete's weight; B - weight of the given athlete; part of the equation $0.56 - \frac{B-60}{900}$ indicates that strength decreases by 0.0011 for each kilogram over 60. We obtained the following figures with this formula:

Weight Class	Index of Mastery (M)
52	5.42
56	5.36
60	5.46
67.5	5.36
75	5.41
82.5	5.49
90	5.51
100	5.11
110	5.09
over 110	5.34

As you can see, athletes in the 82.5-90 kg weight classes have the highest indexes of mastery. The index of mastery is slightly lower in the middleweight class than in the 52 and 60 kg classes. The correlation between vertical jump results and an athlete's level of mastery (master of sport) is 0.54. Consequently, there is some regularity here, although it is not always clearly expressed. Furthermore, the changes in the index of mastery (M) relative to bodyweight, has its own peculiarities (A. N. Vorobyev, 1977).

The height of the jump depends not only on the maximal strength of the muscles in the given movement, but on the time to reach maximal muscular strength, i.e., speed of executing the jump. The latter is associated with the sportsman's bio-dynamic capabilities. Lightweights have lower anthropometric indices and possess lesser biodynamic capabilities than middle-weights (75-90 kg). The reason the heavyweights lag behind in jumping is because they expend more energy overcoming gravity; the heavier and larger the athlete the more energy expended. Apparently, the ratio between anthropometric and biodynamic capabilities of 75-90 kg athletes is optimal, which enables them to realize their speed-strength qualities to the fullest.

Thus, it is expeditious to include bodyweight when drawing-up model characteristics of the vertical jump. The following indices (M±t) were found to express the optimal state of the neuro-muscular apparatus of weightlifters.

1. Maximal grip strength (dynamometer, in kg).

Group 1	52 - 67.5 kg
2	75 - 82.5 kg
3	90 - over 110 kg ;

Masters of Sport:

Group 1	54.5 ± 0.06
2	65.8 ± 0.8
3	75.8 ± 0.9 ;

Candidates to Master of Sport:

Group 1	51.2 ± 1.5
2	63.2 ± 1.3
3	74.4 ± 1.7 ;

Class I:

Group 1	50.7 ± 1.5
2	62.1 ± 1.8
3	69.8 ± 1.5

2. Mean deviation in differentiation of muscular effort of not more than 20%.

3. Vertical jump: masters of sport, 75-90 kg - 72 cm, 65-67 cm for the other weight classes; candidates to master of sport, 75-90 kg - 70 cm, 64-66 cm for the other weight classes; class I, 75-90 kg - 68 cm, 62-64 cm for the other weight classes.

Model characteristics of the functional state of the neuromuscular apparatus of weightlifters in different weight classes and of different sport qualification have great practical significance. They further the athlete's attainment of not some general state, but namely, that which is planned at the moment of competition.

Model Characteristics of Psychological Preparedness. The model characteristics should characterize the athlete's psychological stability during training and competition and include the qualities and peculiarities of personality, the nervous system, psychomotor qualities and the skill to manage one's psychological state under extreme conditions.

Let's look at some works in which the authors attempt to determine the psychological peculiarities of a lifter's successful performances in training and competition.

V. A. Polyakov (1977, 1979) tested the strength of highly-qualified lifters' nervous systems according to excitability. He observed the behavior of these athletes during competition and recorded the time interval between warm-up and competition attempts. This rest interval was called the rhythm of psychological preparedness. V. A. Polyakov established that 2 minutes between snatch and 3 minutes between clean and jerk attempts were the most optimal average intervals. He observed that if the sportsman is ready for the competition then the rhythm of psychological preparedness in the warm-up and competition attempts will be stable. Sharp fluctuations in the rhythm of psychological preparedness during the warm-up is indicative of the athlete's uncertainty, which leads to disturbances in technique on the platform or missed attempts. It has been established that the excitability of the central nervous system reaches maximum 1.5-2 minutes after a lift.

Since the weight of the barbell changes from attempt to attempt during the warm-up (becomes heavier), the excitability of the central nervous system and the rhythm of psychological preparedness change from attempt to attempt and reach maximum over a larger time interval than 1.5-2 minutes. Changes in the rhythm of psychological preparedness, according to the excitability of the central nervous system, are shown in figure 14.

Peak excitation of the central nervous system, at the instant of the first platform attempt, is accomplished by executing the warm-up according to the individualized rhythm of psychological preparedness. The organism prepares for the state which is most favorable for the execution of high intentisy work. This is the basic importance of the warm-up. The art of managing the competition process embraces the skillful preparation of the athlete to execute the forthcoming work on the platform at the necessary instant.

V. A. Salnikov and B. V. Kimeisha (1979) obtained interesting data by studying the typological peculiarities of the nervous system (table 20). This study showed that there were more weightlifters with the weak type of nervous system (according to the process of excitation). There was a predominance of excitation and even-temperedness according to internal and external balance.

The typological peculiarities were determined with E. P. Ilyn's (1972) method. Based upon the data obtained, the authors surmised there are individual differences in a lifter's reaction to certain strength loads. Classified weightlifters with the weak type of nervous system made more progress in the biathlon total using a large training volume (2,600 lifts) than those with a strong type (11.9 and 7.5% respectively). Lifters who have strong nervous systems made significantly more progress with a high intensity training laod than those with the weak type of nervous system (8.8 and 4% respectively).

Knowledge of the regularities of a lifter's reaction to strength loads enables the coach to more effectively manage the training of lifters in the various stages of perfectioning their mastery.

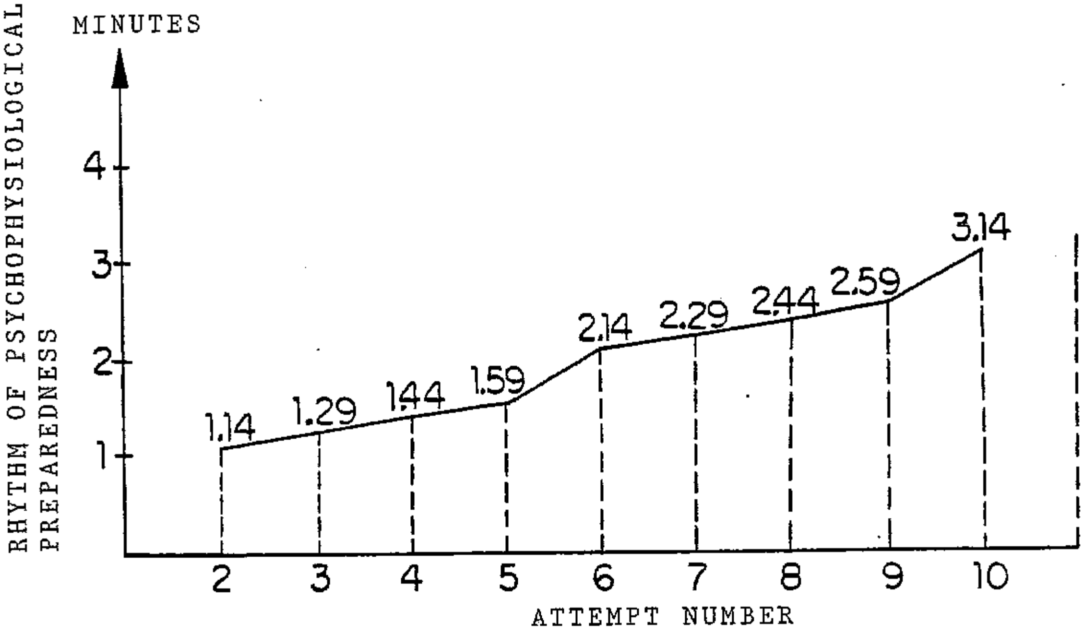


Figure 14. Optimal rhythm of psychophysiological preparedness and excitation of the nervous system for 10 warm up attempts in the snatch (V. A. Polyakov, 1979).

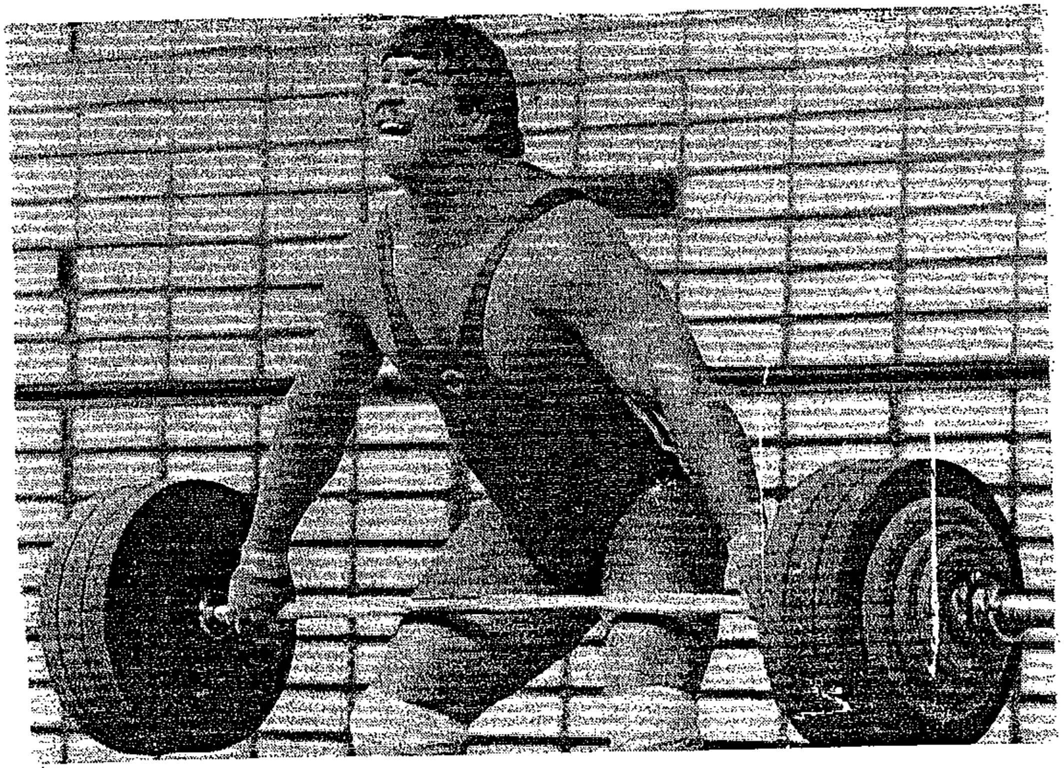


Table 20

Typological Peculiarities of the Nervous System of Weightlifters, %

Qualification	Number of Athletes	Strength of Excitation			Liveliness of Excitation		Liveliness of Inhibition		Bal. of Ext. Excitation and Inhibition			Bal. of Int. Excitation and Inhibition		
		Large	Medium	Small	High	Low	High	Low	Predom. Excit.	Even-Tempered	Predom. Inhibition	Predom. Excit.	Even-Tempered	Predom. Inhib.
Novice	16	20	10	70	31	69	25	75	10	60	30	30	70	-
Class II - II	48	8	17	75	23	77	40	60	44	33	23	40	35	25
Class I - CMS	42	15	23	62	39	61	34	56	52	33	15	30	44	26
MS and MSIC	50	20	18	62	38	62	42	58	52	36	12	24	44	32

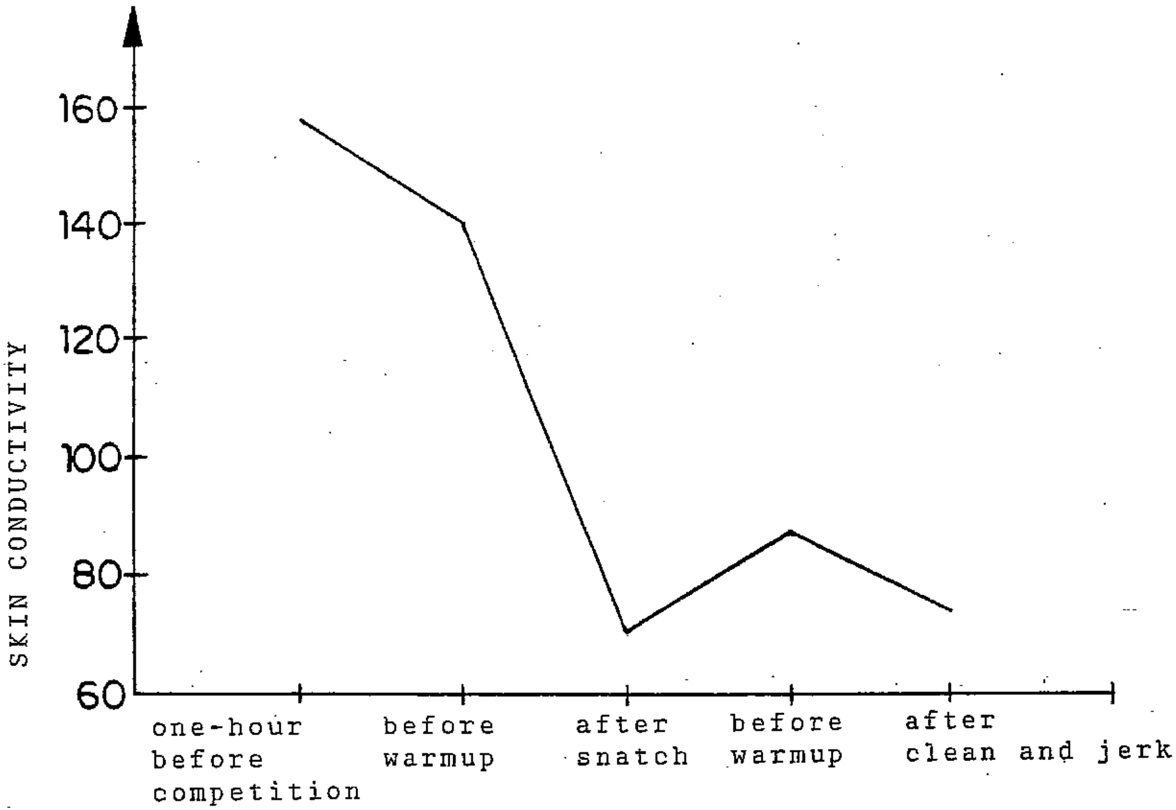


Figure 15. Mean-group dynamics of skin conductivity during competition (V.A. Kanygin, E.G. Kozlov 1978).

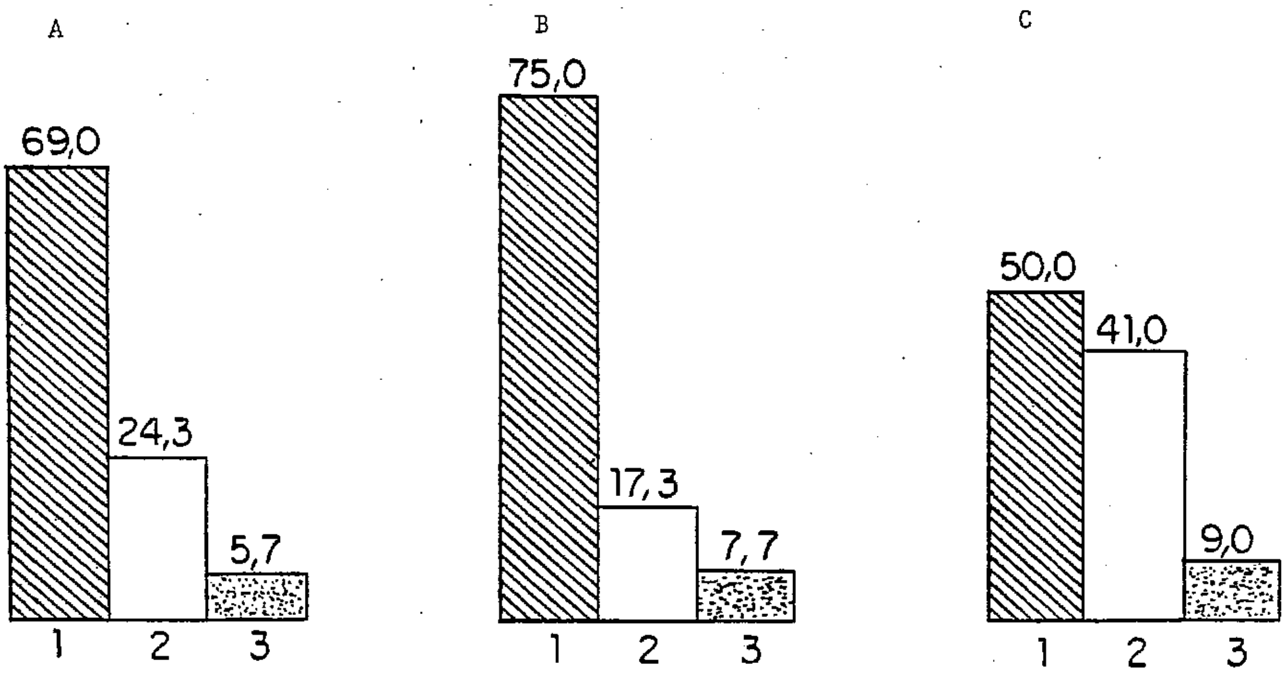


Figure 16. Percent distributuion of maximum motor rate from the day before competition up to the competition in comparison with the mean data in the competition period (A- all athletes before the competition, B- athletes who performed successfully, C- athletes who were unsuccessful; 1- increased rate, 2- decreased rate, 3- no change).

V. A. Kanygin and E. G. Kozlov (1978) studied the use of skin conductivity to assess psychological tension in order to model competition performance. They determined that skin conductivity decreased during the rising psychological tension of competition (figure 15). Psychological tension can be artificially created with ideomotor training. This indicates that it is possible to model competition performance in the laboratory. As has already been mentioned, the tapping-test is used extensively to diagnose the state and the developmental level of an athlete's psychological processes.

Having tested 96 qualified weightlifters (51 masters of sport, 20 CMS and 25 class I) we established, that skin conductivity was slightly below average for the period of investigation, but it rises the day before competition. In the majority of cases, tapping-test results increased by 3% during the competition period. In 69% of the 96 athletes tested the rate increased the day before competition, 24.3% decreased and there was no change in 6.7% of the cases (figure 16).

Consequently, the majority of lifters have the ability to execute movement at a maximal rate at competition time of a successful performance. Lifters who are uncertain of their strength and fear their rivals, have below average tapping-test scores. Those weightlifters who have high psychological stability and high moral-volitional training have higher tapping-test results. The variability of the motor tempo is 5-6% (from the average during the competition period), with 6-8 measurements, in the first group (uncertain lifters, Ed.) and 2-2.5% ($P < 0.05$) in the second group.

So, two indicators can serve as model criteria for the assessment of psychological stability during contest preparation: a) an increase in tapping-test scores of up to 3% during the competition period; b) a variation in tapping-test results (beta) of no more than 2-2.5% from the average. The model characteristics we introduced, help coaches and athletes to effectively manage training and the development of sporting form. Model characteristics can also be used for selecting candidates for the national team.

IV. Reserves for Raising Sport Results in Weightlifting

Managing the Development of a Weightlifter's Physical Qualities in Training

In the management of training, coaches have the opportunity to selectively develop the athlete's physical qualities and secure their harmonious unity in order to accomplish the chosen task. Let's dwell shortly on one of these physical qualities -- strength.

Muscular strength is the maximal tension muscles are able to develop during contraction. There are two regimes of muscular work: dynamic (where the length of the muscle changes during contraction) and static (where the muscle changes its diameter). The dynamic regime can be "overcoming" (where the muscle shortens during movement) and "yielding" (where muscle length increases).

In weightlifting we distinguish between absolute strength, which is the sportsman's maximal strength (for example, best clean and jerk, squat, pull, etc.) and relative strength, which is the ratio of the athlete's absolute strength to his bodyweight. The following is a comparison of absolute and relative strength by weight class.

Weight Class, kg	Maximum Strength (C&J record), kg	Relative Strength
52	142.5	2.74
56	157.5	2.81
60	166.5	2.76
67.5	195.0	2.88
75	205.5	2.74
82.5	222.5	2.69
90	223.0	2.47
100	230.0	2.30
110	240.0	2.18
over 110	256.0	1.96

Essentially, there are two ways of increasing muscular strength. First, strength is developed by increasing the thickness of the muscle fibers; this is why training is organized so that an intense break-down of protein in the working muscles occurs during workouts. The second way of increasing strength is through increasing the innervations of the muscle fibers. In this instance, a perfectioning of the co-ordinational connections to the nervous system occurs, securing improvement of intra-muscular and inter-muscular co-ordination.

Muscular strength depends on: the contractile abilities of individual muscle fibers which make-up a muscle, the initial length of the muscle, the number of fibers in a muscle, physiological diameter and morphological structure of the muscle, character of the innervational influences on the muscle, mechanical advantage of the muscle, degree of emotional tension, time of day, etc.

The more muscle fibers a muscle contains, the greater its strength. Man's muscles are comprised of many neuro-motor units. A neuro-motor unit is a group of muscle fibers (from 3 to 160) which are innervated by one motor-neuron.

There are about 300 million muscle fibers in the body. If all of these fibers could act in concert, then one could lift 25 tons. One should take into account that even with maximal excitation, only 60% of the neuro-motor units are included. The question arises as to whether it is possible to involve more fibers in a contraction? Science answers this question in the affirmative.

The central nervous system and its chief section, the cerebral cortex, play a special role in muscular contraction and the innervation of a large number of fibers. The central nervous system can vary the strength of a muscular contraction by involving various numbers of fibers (neuro-motor units) in the work, as well as by changing the frequency of the impulses sent. The more motor-neurons innervated in a given muscle, the more motor-units are brought into play and consequently, muscular strength increases.

Thus, when perfectioning strength, it is necessary, along with the development of the biochemical and morphological structures, to constantly create conditions for perfecting the co-ordinational connections of the central nervous system. It is advisable that weightlifters execute training lifts with limit and near-limit weights for this purpose because only these lifts make it possible to improve the contractile ability of the muscles and perfect the co-ordination structure of the central nervous system.

Many authors who have studied strength as a physical quality, examine it in four forms.

Absolute-Strength. The greatest force that can be developed during a maximal muscular contraction.

Speed-Strength. The ability to overcome resistance with a high speed muscular contraction.

Explosive-Strength. The muscles' ability to display significant tension in a minimal period of time. The speed-strength index (I), which is the ratio of maximal force to the time it takes to reach it is utilized for the quantitative assessment of explosive-strength. During the execution of the classic exercises explosive-strength is displayed in the "explosion" or in the half-squat before jerking the barbell. In this case the working effect of the movement is determined by the muscles' ability to switch quickly from stretching to active contraction, utilizing the elastic potential of the stretch for raising the power of the subsequent contraction.

Strength-Endurance. The organism's ability to resist fatigue during prolonged strength work. Strength-endurance is characterized by a combination of great strength and significant endurance which makes it possible for athletes to train or compete for a prolonged period of time (3-4 hours) without diminished work-capacity.

Internal and external strength are also distinguished. Internal-strength is the organism's ability to develop force; during this chemical energy is converted to kinetic energy in the neuro-muscular system. External-strength is the force acting on the sportsman's organism during the execution of sport exercise (for example, the force of gravity acting on the body, etc.).

Dynamic and static work are determined by the ratio between internal and external forces.

During the execution of the classic and assistance exercises the sportsman expresses: overcoming work in lifting the barbell, yielding work in lowering it and holding work in holding it. Overcoming and yielding work are of a dynamic character and holding, is static in nature. Internal and external forces are equal in the static regime. The internal stretching of muscle fibers (the muscle's attachments converge) produces muscular tension. This regime of muscular work is called isometric.

Internal and external forces are unequal in the dynamic regime. Internal or external force can be overcome (overcoming or yielding work). Overcoming work is most often involved in sport movements. One is able to move the body or an apparatus as well as overcome resistance in overcoming work. The muscles shorten during overcoming work, and the length decreases. This regime of work is called auksotonic.

Yielding work is involved in lowering a barbell (after fixing it on straight arms) to the chest or from the chest to the platform. The muscles' points of attachment move away from each other during yielding work. Here, muscular contraction can be auksotonic and isotonic (i.e., mixed). Isotonic contraction takes place when the external force is larger than the internal, but the latter is not fully exhausted.

Methods of Strength Development for Weightlifters

One needs to know, first of all, which means and methods to show preference in each stage of perfectioning sport mastery, for effective management of weightlifters' strength training. Let's examine the features of developing absolute, speed and explosive-strength as well as strength endurance.

The maximal effort method is the basic method for developing absolute strength. Essentially, it consists of overcoming maximal resistance in lifting a limit weight. Limit muscular effort is displayed. This is a powerful and effective physiological irritant. The maximal effort method also educates one to opportunely mobilize volitional effort and the skill to switch from maximal tension to relaxation. The maximal effort method increases strength without significantly increasing muscle mass. This is very important for weightlifting, where the athlete is required to keep his bodyweight within certain limits.

Practical experience shows that training with 90-100% of maximum results in the highest increases in strength. These weights should be lifted 1-2 times per set.

The second method of strength development for weightlifters is the repetition method. It consists of repetitively lifting a submaximal weight until fatigued. Although lifts with submaximal and limit loads are distinguished from each other by the physiological mechanism, the first is close in effort to the second, according to the degree of muscular fatigue. Therefore, it is necessary to exercise until fatigued when utilizing the repetition method in training.

The repetition method has its positive and negative points and it is necessary to take both into consideration for strength development. Working to fatigue is not advantageous from an energy standpoint, since it requires a large load volume. Attempts to use this method for the best results (against a background of fatigue) decreases the excitability of the central nervous system, which makes it difficult to form conditioned-reflex connections and further increase strength.

The advantages of this method are:

a) ability to gradually increase the volume and intensity of the strength exercises, which helps prevent injury;

b) ability to control the technical execution of the exercises;

c) significant metabolic displacement with a large volume of work, creates conditions for the "plastic" exchange of substances and furthers functional hypertrophy which leads to an increase in strength.

The variable repetition procedure is the progressive resistance method. With this method the weight is gradually increased from the first to the third set. Ten repetitions are done on the last set. The weight for the first set is 50%, and the weight for the second set 75% of the weight used on the last set.

Usually, weights of 70% and more are used for the repetition method. The maximal number of repetitions is between 6-8. If the athlete's bodyweight is close to the weight class limit or exceeds it, then he should not do more than 2-3 repetitions per set. But, since one is training for strength, it is better if the structural protein of the muscles increases, so we believe 4-5 repetitions per set should be included episodically, because this has the most favorable influence on muscle trophism (A. N. Vorobyev, 1977).

The tempo at which exercises are executed has great significance for the development of strength. It has been established that a moderate tempo produces the highest increases in strength (S. I. Lelikov, 1975).

This fact deserves attention -- up until the onset of fatigue the muscles perform the same number of repetitions when the load is constant as when the load is gradually increased to the same magnitude. Since the heavier the weight the faster the onset of fatigue, it is best to shorten the period of gradual increase in the weight in order to switch to the optimal loads and work with them in the course of the entire workout (S. P. Narilashvili, 1960).

Isometric exercises can be used for development of absolute strength, which need not be displayed quickly. Isometrics are distinguished from dynamic exercises by the fact that there is muscular tension with no change in length. Such exercises can be done with or without a barbell (stopping for several seconds while rising from a front or back squat, stopping in pulls, holding the barbell overhead in certain positions, etc.).

Isometrics have positive and negative points. The positive points are that this method:

a) does not increase muscle mass;

b) does not require large energy expenditure;

c) enables on to strengthen the "uncomfortable" joint angles;

d) does not require a great deal of time.

The negative points of isometrics are associated with the following:

a) only those angles worked are strengthened;

b) static tension inhibits circulation;

c) it is difficult for the coach to control the execution of the exercises.

Isometric exercises are from 6-10 seconds in length and the degree of effort varies from 60% and higher. The majority of specialists recommend efforts close to maximum. It is necessary to warmup before doing isometrics. Static tension should last no longer than 5-6 seconds with a gradual increase in effort that reaches maximum during the last 3 seconds. One should do relaxation exercises during the rest periods.

It should be understood that isometric exercises can not fully replace dynamic exercises. They can only supplement them. One must not over-strain, especially in the initial training stages.

When speaking of special strength training methods, one should turn particular attention to the so-called conjugate method. Essentially, it consists of the momentary influence on the key motor quality to the interconnections corresponding to the specific activity, while preserving the structure of the sport exercise. The conjugate method secures strength development in synthesis with other key qualities while preserving thier rational interrelationships to the muscle groups. Furthermore, it furthers perfectioning of technique by preserving the structure of the sport movement.

The conjugate method is a common method of special strength training for weightlifters. You see, lifters develop strength while executing the special exercises for the snatch and the clean and jerk, to perfect technique. And vice-versa, the use of these exercises for the development of special strength perfects co-ordination awareness, i.e., technique.

The interval method can be utilized for developing absolute strength -- the exercise is repeated with equivalent power and definite intervals;

The variable method -- exercises are repeated without interruption, with different power and intensity;

Circuit method -- uninterrupted execution of a certain complex of exercises of different character (the complex is repeated several times).

The development of speed-strength. Weightlifting is a speed-strength type of sport in which, along with great muscular strength, sportsmen need great speed of muscular contraction because the classic exercises are executed at full strength and speed. Thus, the interrelationship between the two qualities -- strength and speed is very important. It is necessary to exercise with near-limit weights executed at maximal speed for the development of quick strength. These weights will be 80-95% of maximum depending on the athlete (R. A. Roman, 1974).

One needs to constantly develop greater strength and speed of lifting in order to constantly raise the average training weight (this is accomplished by disturbing the homeostatic state and by getting more muscle fibers to participate in the movement).

One should observe two rules when exercising with near-limit weights: a) the exercises should be similar in their coordination structure; b) the weight should be such that it does not significantly decrease speed. As is obvious, it is impossible to solve the tasks indicated using only the classic exercises. It is necessary to utilize the entire arsenal of special-assistance exercises which can be executed with heavier weights and for more repetitions than the classic exercises. Besides comprising a part of the whole classic exercise, special-assistance exercises enable one to develop not only strength and speed but also help improve technique. It has been established that the development of speed-strength is more effective the more speed exercises are included in training and the less slow-speed work is done in training.

Thus, in weightlifting, the optimal weight, movement tempo and the length of work and rest are important conditions for the development of speed-strength. The weight of the barbell and the speed of movement are inversely proportional; in other words, an increase in the amount of weight leads to a decrease in the speed of the movement and fatigue. Therefore, in each case it is necessary to select the optimal combination based on the coordination structure of the exercise.

The development of explosive-strength. Explosive-strength is a general qualitative characteristic appertaining to movements which require the display of neuro-muscular tension in the shortest time and assesses the ability to quickly bring the working force to maximum (Y. V. Verkhoshansky, 1977). Explosive-strength is developed in exercises executed with maximal acceleration, at a maximal tempo, i.e., under such conditions, where the combination of strong tension and speed qualities are required.

Let's dwell at length on the muscles' ability to realize explosive force, characterized as the reactive ability of the neuro-muscular apparatus. The latter is understood to mean the specific ability to display powerful motive force immediately after an intense muscular stretch, i.e., the rapid switch from yielding to overcoming work under conditions of maximal (at the given instant) dynamic resistance. The preliminary stretching results in the accumulation of potential tension in the muscles which is transformed into kinetic energy of movement at the beginning of the contraction. This adds strength, which increases the working effect of the muscles.

Research by V. I. Frolov and N. P. Levshunov (1979) showed that weightlifters, who have relatively high results in the jerk from the chest, execute the half-squat quickly and instantaneously switch to thrusting the barbell. Lifters who stop at the bordering instant between the 3rd and 4th phases of the movement have relatively low results in the jerk. It is obvious from what has been discussed, what sort of significance explosive-strength of the leg muscles has for weightlifters in the execution of the "explosion" in the snatch and the clean and jerk. The speed (time) of switching from yielding to overcoming work is important in all cases.

The so-called "shock" method of developing explosive-strength was developed at the VNIIFK under the guidance of Y. V. Verkhoshansky (1977). The basic idea of this method is to stimulate the muscles by a "shock stretching" which precedes the active effort. A load is not utilized (jumps with a barbell). The kinetic energy, accumulated during a free fall from a certain height is the load.

It is necessary to observe the following when doing "shock" exercises:

a) amortization distance should be minimal, but sufficient to create a shock tension in the muscles. Consequently, the angles of joint flexion should correspond to positions which the working movement of the exercise begins;

b) shock training should be preceded by thoroughly warming up the working muscle groups.

The snatch or clean pull from the hang are examples of exercises for developing explosive strength. It is necessary to first lower the barbell (to the position from which the "explosion" is begun) then rapidly execute the "explosion". To develop the muscles' reactive ability (without resistance) one's own bodyweight can be utilized for the "shock" stimulus. An energetic thrusting upward or up and forward is executed after a depth jump from some height.

The optimal depth of the jump is determined by the sportsman's preparedness. One should land on the balls of the feet with the legs almost straight and slightly tensed. The depth of the amortization should not be large. It is necessary to execute the subsequent jump quickly by energetically swinging the arms.

One should keep in mind the following to develop explosive-strength in the legs:

1) depth jumps require special jumping training with a gradual increase in the volume of jumping exercises. The exercise is done in series of 10 repetitions with 1-2 minutes of rest between series;

2) well trained athletes should do no more than four series of 10 repetitions and lesser trained sportsmen should do no more than two-three series of 5-8 repetitions in one workout. Light running (30-45 meters) and relaxation exercises can be done during the rest between series.

3) depth jumps, in the volume indicated, should be done 1-2

times per week for less trained and 3 times per week at the end of workouts for well trained athletes;

4) depth jumps are appropriate in the second half of the preparation period, in the yearly training cycle. They should be included once every 10-14 days in the competition period and no later than from 10 days before competition.

The development of strength-endurance. Strength-endurance is the lengthy display of muscular tension without diminished work-capacity. Two forms of strength-endurance are differentiated -- dynamic and static. Dynamic strength-endurance is typified by movements of repetitive and significant muscular tension (i.e., of an acyclic character) like weightlifting exercises.

Strength-endurance depends on the economy of the energy processes and the speed with which the energy resources are restored in the muscles as well as on the reserve of strength. As far as strength is concerned bear in mind the following: no weightlifter can do multiple repetitions (8-10) with a weight say 100 kg if his personal best is 102.5 or 105 kg. However, multiple lifts are possible with the aforementioned 100 kg if the personal best if 115-120 kg. This example vividly corroborates the necessity of creating a strength reserve and shows that the task of developing strength endurance is connected to the development of maximal strength.

Strength-endurance is developed from a base of general endurance and the lifter's maximal strength potential. It is necessary to take into consideration the following for development of strength endurance:

1) intensity of the exercises (speed of execution);
2) duration of the exercises (number of lifts);
3) duration of the rest interval;
4) character of the rest;
5) number of exercises in training.

Speed of execution is determined by the "energy securing" of the sport activities. The duration of execution depends on the number of lifts with a given weight. The length of the rest interval is determined by the magnitude of the reaction to the load. The rest intervals between sets should be such that the subsequent repetitions are done in the presence of incompletely restored strength.

The character of the rest affects the speed of recovery. The number of lifts is determined by the total magnitude of the loads. Practical experience shows that it is necessary to train weightlifters for repetitions with optimal weights (80-90% of maximum) to develop strength-endurance. The repetition method is the most effective. One must strive to duplicate the structure of the classic exercises as much as possible when executing the assistance exercises. For this, one should turn special attention to the development of the weaker muscle groups.

As is correct, strength-endurance is developed during the preparation period, when the general volume of the strength work reaches maximum. Training two-three times per day has special significance, because this furthers the development of strength-endurance.

So, multiple repetitions with various weights is the basic method of developing strength-endurance. The intensity is determined by the dynamics inherent to the specialized exercise. If significant effort is required, use the optimal heavy weight in combination with light weights or with exercises imitating the regime of the classic exercises.

By knowing the peculiarities of developing strength-endurance one can selectively influence the lagging qualities and elevate them to the model characteristics. This significantly raises the effectiveness of the management of sporting form and enables one to achieve the optimal physical state at the instant of competition.

Perfectioning of Technique -- the Fundamental Reserve for Raising Sport Results

An important factor of the successful training of weightlifters is the technical mastery of the classic biathlon exercises. What good qualities would an athlete lack and what sort of mistakes in the execution of the classic exercises would lead to failures -- the utilization of only one attempt in a movement and to "bombing out".

M. V. Starodubtsev, A. S. Medvedev and Y. A. Sandalov's (1980) data shows that even at all-Soviet and international level competitions there are a rather large number of "bomb outs" and lifters who only make one attempt in an exercise (table 21). As can be seen in the table there are more "bomb outs" at the USSR national championships (18-34%) than at international events (about 15%). It has been established that "bomb outs" and performance of only one successful attempt in an exercise occurs more frequently in the 82.5-110+ weight classes than the lighter 52-75 kg catagories. For example, there were 9 "bomb outs" in the 52-75 kg classes at the 1980 Olympics and 18 in the 82.5-110+ classes. Nearly the same regularity occurs in other competitions.

For example, analysis of the results of the 1977 USSR (Ukranian, Ed.) championships in Dneprodzerzhinsky showed that of the 399 attempts allotted to 133 weightlifters in the snatch, 255 (64%) were unsuccessful; and 22 lifters (16%) "bombed out" in this exercise. Of the 304 attempts in the clean and jerk 160 (52%) were misses. 37% of all the missed clean and jerk attempts involved the failure in the jerk portion of the lift. Eight athletes "bombed out" in this exercise.

The most frequently seen mistakes in the snatch and the clean and jerk are presented in table 22. In the snatch the most frequent errors are: distortion in barbell trajectory (64%) and incomplete extension of the torso in the "explosion" (27%); in the clean and jerk these errors are: distortion in barbell trajectory (28%) and insufficient use of the legs when the barbell is not jerked successfully (21%). Consequently, more than one-half of the missed snatch and the clean and jerk attempts are due to mistakes in technique.

Our data corroborates that of L. N. Sokolov (1977). His analysis of the weightlifters' attempts at the VI Summer Spartakiade established that the most frequent error in the snatch was distortion of barbell trajectory (85.7%). In the clean and jerk 35.6% of the errors occur during the clean and 64.3%, during the jerk. The most frequently occuring error in the

Table 21

Number of "Bomb Outs" and only One Successful Attempt in Important Competitions

Competition	Exercise	# Participants	# "Bomb Outs"	Percent of Part.	Only one Success	Percent of Part.
1976 USSR Championships	Snatch	143	16	11.2	69	48.2
	C & J	129	18	14.0	58	45.0
	All	143	34	23.7		
1976 USSR Cup	Snatch	185	22	11.9	87	47.0
	C & J	168	13	7.7	79	47.0
	All	185	35	18.9		
1977 USSR Championships	Snatch	145	39	27.2	79	54.5
	C & J	123	11	8.9	71	57.5
	All	145	50	34.4		
1977 USSR Cup	Snatch	185	22	11.9	87	47.0
	C & J	173	27	15.6	69	39.9
	All	185	49	26.4		
1977 World Championships	Snatch	186	9	4.8	86	46.3
	C & J	178	19	10.7	87	48.9
	All	186	28	15.0		
1980 Olympics	Snatch	172	13	7.5	77	44.7
	C & J	159	14	8.8	77	48.4
	All	172	27	15.6		

clean is distortion of barbell trajectory (51.3%). The most frequent error in the jerk is insufficient use of the legs (the barbell is not "thrust") [62.2%] and in 34.4% of the misses there is distortion of barbell trajectory. One can conclude that the majority of weightlifters are most often lacking in jerk technique.

Qualitative analysis of important Soviet and international competitions were conducted to show coaches and athletes what sort of reserves are latent in the technical execution of the exercises if it is constantly perfected. It is necessary to include classified-sportsmen and athletes on the national team -- extra-class athletes, in the questions of technical mastery. A. N. Vorobyev, merited master of sport, writes about the role of technical mastery (1974): "The use of special apparatuses of crucial information, various training benches, devices and means of restoration are among the large reserves for assisting technique."

The successful execution of all three competition attempts in each exercise depends on the athlete's technical preparedness and stability in executing the classic exercises. In weightlifting, stability of sport technique is understood to mean a lifter's skill to confidently execute the classic exercise, with an accessible weight, under any competitive conditions. The weightlifter's skill to commensurate his effort with the weight of the barbell, especially in the fundamental phases of the classic exercises (L. N. Sokolov, 1977), plays an important role here.

The absence of so-called weak links in the chain of components making-up the classic exercises has great significance for the reliability of an athlete's performance. Despite the fact that technique should be individualized, specialists devise general movement parameters essential for the successful performance of the exercises.

Let's examine the possibilities for perfectioning technical mastery in the snatch. At the present time the snatch is divided into six phases: I - the interaction of the athlete with the barbell up until the moment of separation; II - the preliminary

Table 22

Most Frequent Technique Errors of Qualified Weightlifters in Competition

Reasons for Snatch Misses	%
Pre-mature inclination of torso backwards	1
Incomplete extension of torso during the "explosion"	27
Press-out	2
Distortion in barbell trajectory (bar falls forward or backward)	64
Jump back	1
Unable to recover from the squat	1
Hesitation (executed Pull)	2
Did not lock-out bar	2
Reasons for Clean and Jerk Misses	
Incomplete extension of torso during the "explosion"	1
Distortion in barbell trajectory during the clean	8
Knee-touch (Elbow)	4
Hesitation (executed Pull)	8
Jumping back	–
Unable to pull bar high enough	5
Unable to recover from the squat	15
Insufficient working of the legs (not "thrust")	21
Distortion in Jerk trajectory	23
Press-out	1
Did not lock-out bar	14

acceleration of the barbell; III - the movement of the knees under; IV - the final acceleration of the apparatus; V - the interaction of the athlete with the barbell in the non-support position; VI - the interaction of the athlete with the barbell in the support position. Phases I and II are combined into one period -- the pull, III and IV into the "explosion" and phases V and VI into the "squat under" (V. I. Frolov, A. A. Lukashev, 1978).

Before executing the snatch, it is necessary for the athlete to assume the optimal starting position for the effective utilization of his physical capabilities in order to impart maximal vertical acceleration to the barbell in the second period. We distinguish the preliminary starting position from the dynamic. One follows the other. The preliminary starting position is the pose from which the sportsman begins the interaction with the barbell. The dynamic starting position is the instantaneous pose the athlete assumes at the instant the barbell leaves the platform. The dynamic starting position has decisive significance for the subsequent movement of the barbell. Beginning with this instant, the weightlifter and the barbell represent a unified system.

In weightlifting, the preliminary acceleration question is highly controversial in theory and in practice. For the snatch, some specialists recommend that the barbell be lifted smoothly at the beginning with a low initial speed, while others recommend maximal initial acceleration. If one bases the latter recommendation on the connection between the impulse force in the second phase and the "explosion", then it is of course correct to begin the snatch with maximal initial acceleration. But, if one considers the first peak of force against the support, then it shows that an extraordinarily large force at the beginning of the second phase is associated with the active extension of the lower extremities up to a large magnitude (angle of knee flexion -- 155-170°) in the second phase without preserving the true interaction between the links in the kinematic chain. So, one should strive to increase the impulse force in the preliminary acceleration, but not try to increase the first impulse force against the support.

When perfectioning snatch technique it is necessary to pay particular attention to the switch from the moving the knees under phase to the final acceleration phase. Goniometric analysis shows that athletes who commit erros in snatch technique have a pause between the third and fourth phases. Therefore, when working on the "explosion" in the snatch, one needs to switch quickly from the third to the fourth phase, i.e., from yielding to overcoming work of the leg muscles. This rapid switching can be controlled by utilizing goniometric data of the knee joints during the execution of the weightlifting exercises.

The rhythm of the lift by phases (if the execution time of the snatch from the instant of barbell separation up to the "squat under" is taken as 100%) should be as follows: second phase - 59%, third - 17%, fourth - 24%. Such a snatch rhythm, up to the "squat under", ensures that the execution of the entire exercise is correct. So, it is necessary to observe the following basic requirements for the execution of the snatch:

1. Rigid interaction of the links of the kinematic chain (consisting of the execution of the pull and the moving the knees under phase on the whole foot with the back and the arms straight and the partial fixation of the arms at the shoulder and elbow joints).

2. Maximal amplitude of the movement and use of the arms to actively influence the apparatus in the final part of the "explosion".

3. Selection of the maximum possible hand spacing for each athlete.

Now let's analyze the technique features of the clean and jerk. The pull phases of the clean and jerk are the same as in the snatch. It is necessary to begin the clean and jerk by actively extending the legs. The barbell should be separated from the platform smoothly and subsequently accelerated up to the instant of the "explosion". The preliminary acceleration phase lasts an average of 0.47 seconds. The barbell is raised to an average height of 50 cm at the bordering instant between the pull and the "explosion". At this point, knee angles reach an average of 157°. During the clean, the moving the knees under and the final acceleration phases are approximately equal -- and last from 0.13 to 0.15 seconds each.

After the barbell has separated from the platform, the shoulders shift forward and upward and the bar shifts backwards towards the athlete. The movement of the shoulder joints forward from the vertical line of the bar continues until the instant the barbell reaches knee level. Then, in preparation for the "explosion", the shoulders move upward and backwards. The counter movement of the barbell and shoulder joints is necessitated by the convergence of barbell's and the athlete's center of gravity and the effort to decrease the moment force of resistance, relative to the ankle, knee and iliofemoral joints.

Although athletes of different height and body proportion manifest different times and amplitudes of movement in the phases, the degree of realization of motor potentials does not depend on the athlete's body structure but upon his sport technique (A. N. Vorobyev, 1977).

The duration of the non-support position in the clean depends on the athlete's height. The length of time taken to rearrange the feet to a new place of support increases with increasing height. The duration of the non-support position decreases with the increase in qualification. The duration of the non-support position is 0.143 seconds for novices lifting 95% of maximum and only 0.099 seconds for qualified weightlifters. The length of time to rearrange the legs to the new place of support also depends on the weight of the barbell. The length of time qualified weightlifters take to rearrange the legs decreases as the weight increases -- from 0.129 seconds (with 55%) to 0.099 seconds (with 85%).

During the clean the athlete should rise as fast as possible from the squat position so as to expend less effort in this part of the movement. The speed of the recovery from the squat position depends on the strength of the legs (the greater the leg strength the faster the recovery) and the amount of weight (the athlete takes more time to rise from the squat as the weight increases). According to A. T. Ivanov's data (1977) athletes require an average of 1.8 seconds to recover from the squat on the first attempt, 2 seconds on the second and 2.2 seconds on the third. Athletes who fail in the jerk portion of the lift expend 2.5 and 2.6 seconds respectively to recover from the squat on the second and third attempts. Consequently, recovery time is shorter with successful jerk attempts. It has also been shown that recovery time increases with the increase in weight class. The correlation between these parameters is 0.80.

Average recovery time in each weight class is: 52 kg - 2.01 sec., 56 kg - 2.04 sec., 60 kg - 2.08 sec., 67.5 kg - 2.14 sec., 75 kg - 2.21 sec., 82.5 kg - 2.27 sec., 90 kg - 2.34 sec., 110 kg - 2.51 sec., over 110 kg - 2.7 sec. So, it is necessary to turn attention to recovery time from the squat when perfecting technical mastery.

The jerk portion of the clean and jerk is the final part of the classic clean and jerk. The success of a sportsman's performance in competition depends a great deal on this part of the lift. The complexity of this movement consists of this -- the athlete has to interact with the elastic-deformation of the bar. The structure of the jerk has been the subject of many studies. This question has been most fully studied by V. I. Frolov and N. P. Levshunov (1979). They divided the jerk into three periods and six phases.

The first period -- the half-squat consists of the preliminary half-squat (phase I) and the phase of the active half-squat (phase II). The second period is the jerk proper which consists of the "braking" phase (phase III) and the thrust phase (phase IV). The third period is the "squat under" which includes the non-support phase of the "squat under" (phase V) and the support phase of the "squat under" (phase VI).

The first phase (average duration is 0.17 seconds) encompasses the interval from the instant the knees begin to bend to the instant the barbell begins its downward movement. As the athlete begins the half-squat the ends of the bar remain in place and the center of the bar is lowered in this phase. At this instant, the knees bend to an average angle of 155°. The second phase (average length 0.17 seconds) begins the instant the barbell begins to move down and ends when it reaches maximal velocity in the half-squat. Knee angles reach 126°.

The third phase (average length 0.14 seconds) begins the moment the barbell reaches maximal velocity in the half-squat and ends the instant the knees reach maximal flexion. The "braking" of the barbell occurs in this phase. The knee angles decrease from 126 to 118°. At the instant the "braking" phase is concluded, the speed of the apparatus is zero and the bar is bending to its maximum. The fourth phase (average length 0.26 seconds) begins from the maximal flexion in the knees and ends at the maximal extension of the knees.

The fifth phase (average length 0.20 seconds) encompasses the interval from the maximal extension of the knees to the instant the barbell reaches its maximal height in the lift. At this instant, the athlete rearranges the legs in the saggital plane. The non-support time during the rearrangement of the legs averages 0.08 seconds. The sixth phase lasts an average of 0.20 seconds. It begins the instant the barbell reaches maximal height and ends the instant the barbell is fixed in the split position.

It has been established that the "braking" is the fundamental phase in the jerk. The shorter the "braking" phase the greater the force against the support ($r = -0.79$). The faster the switch from the half-squat to the thrust the larger the motor potential created in the muscles, the higher the working effect.

After the braking phase, the switch to the thrust phase lasts 0.1-0.13 seconds for athletes who make successful jerks. Athletes with relatively low results in the jerk take 0.2 seconds to complete the third phase. Furthermore, they pause at the bordering instant between the third and fourth phases for 0.06-0.08 seconds. Consequently, the effectiveness of the thrust depends not only on the quickness of the "braking" phase but also on the quickness of switching from the third to the fourth phase. It is necessary to pay special attention to this when training on the jerk.

A comparative analysis of the snatch and the clean (V. I.

Frolov, A. A. Lukashev, 1978) showed that the difference in the technique of these exercises is caused chiefly by the heavier weight and the narrower grip in the clean. The difference in the width of the grip results in the athlete's shoulder girdle being 10-15 cm higher in the starting position for the clean than in the snatch. This is because knee joint angles (84°) for the clean are larger than in the snatch (74°).

The lengths of the separate phases are different: the preliminary acceleration phase of the snatch lasts 0.43 seconds. This phase lasts 0.47 seconds in the clean. In the snatch, the movement of the knees under phase is significantly shorter than the final acceleration phase (third phase - 0.13 seconds, fourth - 0.17 seconds), but in the clean the movement of the knees under phase and the final acceleration are approximately equal.

Thus, there are significant differences in the coordination structures of the snatch and the clean. It is necessary for coaches and athletes to remember that in order to avoid the negative transfer of motor habits one should not frequently mix snatch and clean exercises in training.

Technique training is carried-out by repetition of special exercises, the spatial and time structure of which are similar to the competition exercises. We conducted a comparative analysis of the snatch and the power snatch and the clean and the power clean (table 23).

Table 23

Length of Phases (sec) and Optimal Knee Angles (degrees) of Competition and Special Exercises

Exercise	Length of Phase				Border of Phases		
	II	III	IV	V-VI	II-III	III-IV	IV-V
Snatch	0.50	0.14	0.14	0.58	142.0	120.6	165.9
Power Snatch	0.43	0.13	0.14	0.42	142.1	124.4	170.8
Clean	0.56	0.13	0.13	0.69	146.0	131.2	159.5
Power Clean	0.48	0.12	0.12	0.49	145.6	128.7	167.1

The data obtained indicates that time of execution of phases III and IV in the snatch and the power snatch coincide but, preliminary acceleration time and "squat under" phases are different (the difference is statistically significant). This is because a significantly heavier weight is raised in the snatch (90% and above) then in the power snatch, which is on the average 80.2% of the best snatch.

The same can be said about knee angles. Knee angles at the beginning of the movement of the knees under phase and at the end of it are equivalent; and it is only at the end of the final acceleration that they are different. This is associated with differences in the amount of weight. One should point out that the lift should not be considered a power snatch if knee angles are less than 70° in the squat position. Since the movement of the kness under and the final acceleration phases are fundamental to the execution of these two exercises, training on the power snatch can preserve the structure of the competition exercise and secure the positive transfer of motor skills from the power snatch to the snatch.

We noticed that the third and fourth phases of the clean and the power clean also coincide. The significant difference in the "squat under" phase in these exercises is due, obviously, to the fact that a lesser weight (average of 83% of maximum) is lifted in the power clean than in the clean. Such a weight requires a large amplitude of movement in the knee joints during the execution of the special exercise (up to 167.1°, versus 159.5°). Thus, the conclusion based on the analysis of the snatch and the power snatch is valid for these two exercises also.

It is known that even high-class athletes commit errors in technique and that some sportsmen have optimal technique for their given sport qualification but are unable to increase their results due to insufficient strength. We were interested in the question: as to whether there are differences in master of sports' and class I athletes' goniographic parameters during the execution of the exercises. We did a comparative analysis of data from the snatch and the clean to answer this question. The analysis showed that the general time of the snatch was shorter for masters of sport than class I athletes. There were no essential differences in the duration of the individual phases. However, the masters of sport had better snatch technique. A close intercorrelation between the duration of the final acceleration phase and the weight of the barbell was established (r = 0.71; table 24). Class I athletes lack such an intercorrelation. There were no significant differences in knee angles. For masters of sport, knee angles decrease with the increase in weight-height data or the amount of weight (r = 0.57).

Table 24

Goniographic Indices for the Snatch and the Clean

Exercise	Qualification	Length of Phase				Border of Phase		
		II	III	IV	V&VI	II&III	III&IV	IV&V
Snatch	MS	0.50	0.14	0.14	0.58	142.0	120.6	165.9
	Class I	0.54	0.15	0.15	0.59	142.5	118.7	164.9
Clean	MS	0.56	0.13	0.13	0.69	146.0	131.2	158.5
	Class I	0.68	0.12	0.15	0.66	144.4	126.0	166.0

The same regularity was noticed for the clean. There were no substantial distinctions in the goniographic indices of masters of sport and class I athletes. However, there were substantial intercorrelations between final acceleration time and the weight of the barbell (r = 0.57) and the weight-height data (r = 0.62). For masters of sport there is a negative correlation between weight-height data and degree of knee extension at the end of the final acceleration. The latter decreases as the weight of the barbell increases (r = -0.44). There is no such intercorrelation with class I athletes.

Consequently, based on all of the goniographic parameters obtained from athletes of different qualification, only the masters of sport indices intercorrelate with their sport results. Obviously, the stability and economicalness which distinguishes the technical execution of the classic exercises by these athletes is due to the level of trainability they achieve in the competition period. Class I athletes commit more technique errors therefore their indices are more variable. This has a negative influence on the intercorrelation between goniographic parameters and sport results.

From what has been said one can conclude that: if a class I athlete's technique is close to that of a master of sport, then he should concentrate more on special strength training in order to achieve master of sport results.

Is it necessary for athletes to perfect technique at all levels of sport perfectioning? Yes, it is necessary. The fact is that each sportsman learns the fundamentals of technique at the outset of sporting activities, but in the process of training develops his strength capabilities and other physical qualities and they can be developed unequally. The sportsman "adjusts" his technique to his dynamic capabilities at each stage of training. Thus, he constantly works at perfectioning technical mastery. However, the "optimal level of technical mastery" will obviously be characteristic of only the given, concrete period of training.

A Little About Biorhythms

Recently in sport, in medicine and some other spheres of man's activities the theory of biorhythms has become well known. It asserts that any biological phenomenon, any physiological reaction relating to periodicity and all functional systems like an organism are rhythmic systems. The rhythmicity of the biological precesses indicates that the life-processes of phenomena flow in space and time.

Up to now the question as to whether "biological clocks" are clearly internal (endogenic) or are regulated by external (exogenic) influences, has been disputed. A number of studies have considered that different organisms are extraordinarily sensitive to shifts in geophysical factors. Others are of the opinion that the rotation of the Earth on its axis does not exert a significant influence on organisms, since plants and animals retain their 24-hour rhythms, even at the South Pole (N. A. Agadzhanyan, 1975).

Although the presence of "biological clocks" in both man and animals has been proven, the mechanism of their action remains unclear. The affect of the "biological clocks" on the 24-hour daily cycle has received the most study. The daily or circadian rhythm of body temperature changes, heart rate, etc. have been well researched. At approximately 6:00 P.M. body temperature reaches maximum. It decreases by midnight. The lowest heart rate occurs at 4:00 A.M. and the lowest blood pressure is noticed at 10:00 A.M. Blood-hemoglobin reaches maximum in the evening from 6:00 P.M. to 8:00 P.M.

In recent years, along with research of daily biological rhythms, rhythms of other duration -- many-days, months, seasons and years, have been studied. Some weightlifting specialists began applying the theory of biorhythms to weightlifting. Some coaches and athletes want to study biorhythm regularities in order to more effectively manage sporting form.

For a long time it has been a known fact that sportsmen feel different at different times: on some days they notice a flood of strength, feel vigorous, in good spirits and have a high work-capacity; on other days they notice the reverse -- loss of strength, sluggish, absent-mindedness and diminished work-capacity. At the end of the last century, Hungarian psychologist G. Svobodoi and German physician V. Fleisom advanced the theory of multiple-day biorhythms. It has both ardent supporters and opponents. According to this theory, man's life-processes are regulated by three periodic cycles -- physical, emotional and intellectual (A. V. Kinkadze, 1975). Let's examine each cycle with regard to weightlifting.

The physical cycle which is 23 days in length determines a person's energy, strength, endurance as well as movement coordination. The first "positive" half of the cycle lasts 11.5 days and is characterized by higher work-capacity. The sportsman usually shows his best results in this period (from the 2nd to the 9th day) and the coach is able to determine his capabilities. An individualized biological chart of the sportsman is a big help to the coach.

The athlete's strength decreases, he has less energy and speed decreases in the second "negative" half of the cycle (11.5 days).

The emotional or psychological cycle of 28 days duration characterizes the state of the sportsman's nervous system. In the first 14 days of this cycle he is full of optimism, cheerful, aggressive and usually over-estimates his capabilities. The positive emotional disposition enables one to fully cope with any work regardless of time or difficulty and enables one to cope with any difficult sport tasks.

Emotions are directly opposite in the second-half of the period; sportsmen are irritable and given to critical analysis of their capabilities (this is especially noticeable in excitable people). There is rapid fatigue and diminished work-capacity.

The intellectual cycle lasts 33 days. It determines the person's creative capabilities. They recommend that one should concentrate on theoretical preparation during the first-half of this cycle (16.5 days), to develop motor skills and to learn and improve technique. During the second-half of the cycle memory and the ability to learn and correct mistakes decreases and it is better for the athlete to switch to consolidating material already mastered. Biorhythms were first utilized in practice by American weightlifting coaches in 1946. They established that the optimal periods for training and competition are when the physical and emotional cycles coincide in a positive phase. Such periods are repeated every 4-5 months and last from 8-11 days.

Depicted graphically biorhythms look like sinusoids of various length. A horizontal line drawn through the center should divide the positive and negative phases of all three cycles. The days when the sinusoid of some rhythm intersect the horizontal are called critical because the state of the organism on such days, in connection with the reconstruction going on within it, is extremely unstable. If two sinusoids intersect the horizontal simultaneously, this is the so-called double critical day and if there are three -- a triple critical day. The coincidence of the emotional and intellectual critical days with the critical days of the physical cycle is considered extremely dangerous, because the adherents of this theory believe the organism's resistance to disease is lowered.

In order to make-up combined biorhythm schedules it is necessary to consider the number of days since the date of birth, to the present. Then, this number is divided by the number of days of a certain cycle. Obtain a whole number and the remainder. The end of the last and the beginning of the next biological cycle can be determined by the remainder.

In sport, adherents of the biorhythm theory maintain that the coach and athlete should know when maximal achievements can be accomplished. Opponents of the biorhythm theory, with regards to a poor work-capacity and from the standpoint of sporting results, consider it best that the athlete be unaware of this. We advance the following argument with respect to that assertion: if the sportsman is forewarned of an unfavorable physical and emotional state at competition time he can improve his state and create reserves of strength capabilities (in order to realize them in competition) by utilizing a variety of training means. However, this is only possible if the sportsman is at a high level of volitional and psychological preparedness. If the reverse is the case, then reminding him of the fall in work-capacity can have a negative influence.

They call in question the fact that everyone is under the influence of these cycles, each with a set duration. Adherents of this theory assert that the "biological clocks" are the most precise and perfect in nature and all organisms function by them, independent of national origin and age. The periodicity of the cycles of 23, 28 and 33 days are considered equivalent for everyone.

The latter viewpoint was corroborated by V. S. Kopysov and V. I. Shaposhnikov's research (1979). They studied the effectiveness of planning training loads for weightlifters by the 23 and 28 day biorhythms. Forty-nine men (novice and classified athletes) took part in the study. They were divided into experimental and control groups.

In the experimental group, loads were individualized according to each subjects' 23 and 28 day biorhythm. The volume and intensity were increased in conjunction with the positive phase and decreased with the negative phases of the biological rhythms. Maximal lifts were planned to coincide with the positive phases. The weightlifters in the control group executed the same volume of work as the experimental group, but trained without regards to the multi-day biorhythms.

Statistical data showed there was a significant difference in the increase in results of the experimental and control groups. The weightlifters in the first group increased their results 12.9% and those in the second by 10.2% ($P < 0.05$).

Motor qualities were determined daily on these lifters (standing dynometria, vertical jump, number of squats with 50% of the maximal clean and jerk for 20 seconds) which were then distributed according to the three groups of days of the physical biorhythm: the first group from the 2nd to the 11th day (positive phase), the second group from the 13th to the 22nd day (negative phase) and the third group -- 1st, 12th and 23rd days (critical days). The differences in the mean significance between the first and second and between the first and third groups are statistically reliable ($P < 0.05$). The motor quality indicators coincided with the phases of the calculated 23-day biorhythm: standing dynamometer strength in 73.5% of the cases, vertical jump in 68% of the cases and 74% of the cases in the number of squats. The results of the experiment corroborate the expeditiousness of calculation and the utilization of the regularities in the fluctuations of physical activeness of athletes.

The most interesting data was obtained while studying multi-year biorhythms.

V. I. Shaposhnikova (1974), investigating the multi-year dynamics of sport results (by the months from the date of birth) of 554 of the world's best track athletes. She analized 7,062 sport results from 1969-1973 and established that the fundamental growth of sporting results occurs in conformity with the repetition of the favorable phases of the endogenous rhythms. Significant spasmodic improvement in sport results for men were noticed primarily every 3 years (for example at ages 16, 19, 22, 25 and so forth) and for women every other year (for example, at 15, 17, 19, 21 and so forth). Although there are exceptions, this rhythm appears quite clearly at the regular performances of the world's strongest athletes in competitions over many years.

V. I. Shaposhnikova and her colleagues consider that this rhythmicity is due to the changes in the immune strength of the body and that such changes are also subject to a certain rhythm up and down. The many-year dynamics of weightlifters' biathlon results have also been researched (V. I. Shaposhnikova, Y. V. Duganov, V. N. Lupkihin, 1974). The increase in results at certain time intervals (several years) were considered the criteria of the sportsman's change in trainability. L. Zhabotinsky's multi-year growth in sport results is shown in figure 17. It is obvious that Zhabotinsky's results in the triathlon increased significantly every three years. The relative summed increase in results of the World's and USSR's best weightlifters during the years of significant rise and fall of their physical capabilities were analyzed (table 25). It was found, that in all cases the increase in results during the years of a rise in the athlete's physical capabilities significantly exceeded the summed increase in results achieved over the largest time period in the remaining years of training. For example, Y. Vlasov improved his triathlon results by 150 kg from ages 21 to 29; by 22.25 at 28 years of age (over two years), i.e., for the first 3 years, by 100 kg (66.5%) and in the remaining five years, by 50 kg which is 33.5% of the general increase.

Consequently, the regularity of the fluctuation in the rise of physical capabilities (under rational training conditions) enables sportsmen, in the process of many-years of training, to achieve high sport results in a "stepped" fashion. Therefore, it is necessary that coaches, when planning training loads and prognosing sporting achievements, consider the three-year biological rhythm in order to achieve the highest results in these years. V. I. Shaposhnikova and V. S. Kopysov (1978) researched and corroborated the hypothesis concerning the regularities in the distribution of the best sport results of the world's

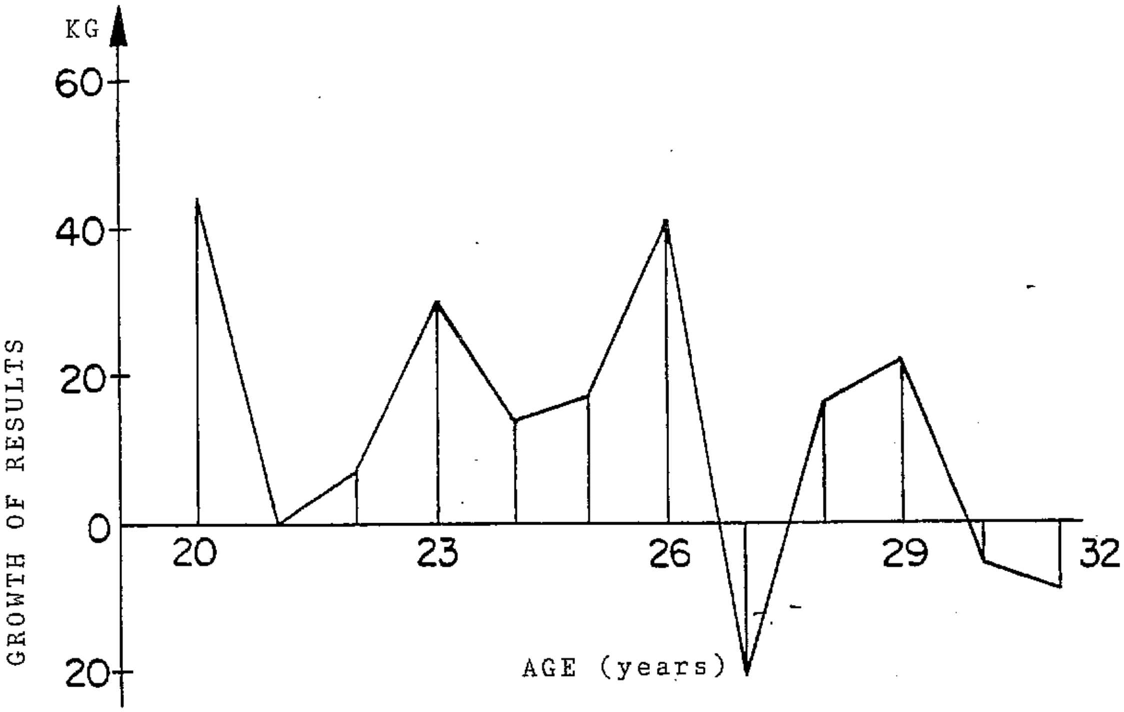


Figure 17. The dynamics of L. Zhabotinsky's results in the triathlon total.

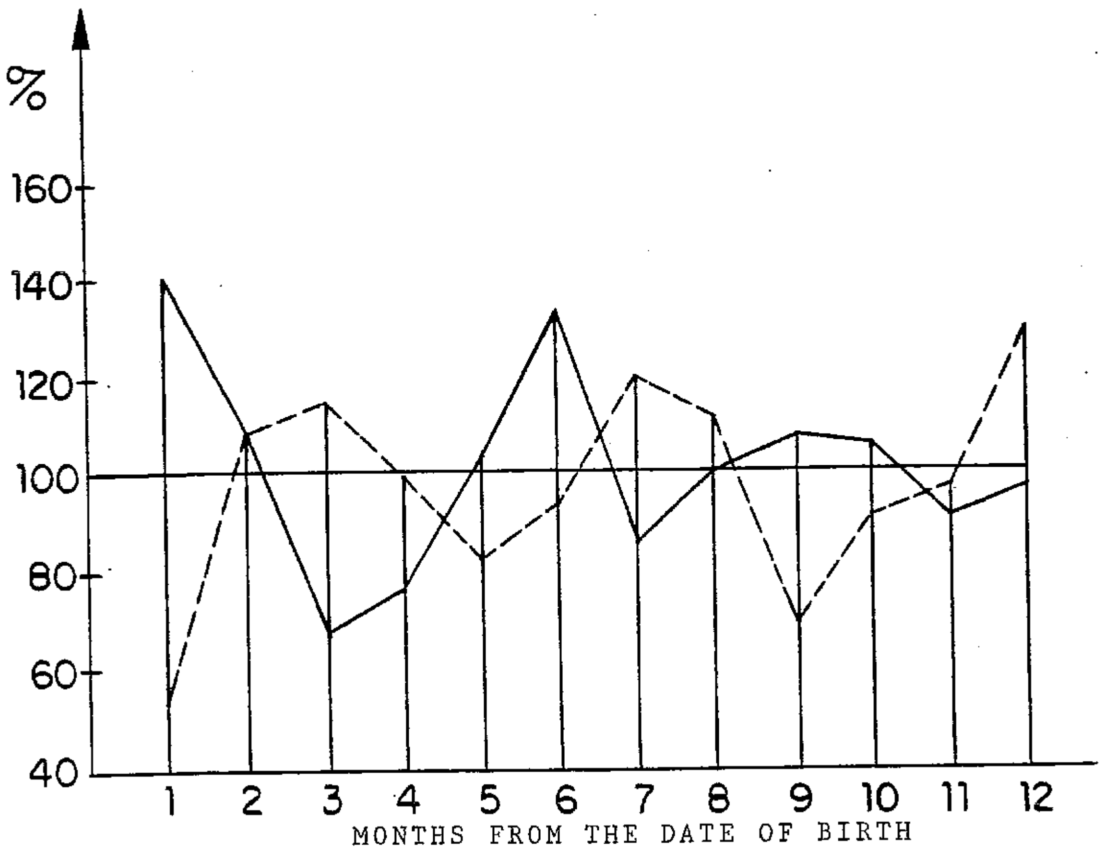


Figure 18. Distribution (by months from the athlete's date of birth) of 915 of the best (continuous line) and worst (broken line) results of the season of a number of the strongest weightlifters, in percentage of the year average (V.I. Shaposhnikov, V.S. Kopysov, 1978).

Table 25

Correlation of Total Increases in years when Physical Potential Increased Significantly

Weightlifter	Age Period Studied	Improvement in Total, Kg	Ages Total Increased	Summary of Increases in Total: Years Improvement Made			Remaining Years		
				# Years	Increase, Kg	%	# Years	Increase, Kg	%
L. Zhabotinsky	19-31	175	20,23,26,29	4	145	83	8	30	17
L. Martin	22-33	110	23,26,29,32	4	97.5	88.5	7	12.5	11.5
Y. Wasov	21-19	150	22,25,28	3	100	66.5	5	50	33.5
A. Kurynov	22-31	110	23,26,29	3	80	72.5	6	30	27.5
N. Ozimek	18-25	92.5	19,22,25	3	77.5	84	4	15	16
A. Kidyaev	23-30	135	24,27,30	3	92.5	68.5	4	42.5	31.5
V. Kanygin	17-23	237.5	18,21	2	150	63.5	4	87.5	26.5
V. Kolotov	21-27	155	23,26	2	107.5	69.5	4	47.5	30.5
Y. Talts	19-27	185	19,22,25	3	117.5	63.5	5	67.5	36.5
S. Lopatin	20-27	50	21,24,27	3	37.5	75	4	12.5	25

strongest weightlifters in the course of a year. By analyzing 915 of the best and 915 of the worst results in the yearly training cycle, they established (figure 18) that results increased in the 1st month from the date of birth as well as in the 5th, 6th, 9th and 10th months in comparison with months 3, 4, and 12 from the date of birth. Thus, one can consider it a fact that for the majority of athletes, the most successful performances occur in the months indicated. Nevertheless, regular sport training enables an athlete to mobilize and show high sport results, for a given level of trainability, even when he is in (for him) an unfavorable period. However, if there is any deviation in the state of health, "frustrations" in competition are more likely during this period. Illnesses of junior athletes for whom high training loads are planned can be caused by exhaustion of the organism's adaptational systems.

There are many opponents of the adherents of biological rhythms of three periodic cycles (23, 28 and 33 days). V. A. Peegel's (1975) data enabled him to expand the notion of the existance of athlete's of 23, 28 and 33 day rhytmicities. In his study sportsmen were divided into two groups: in the first group hard training was planned (by the volume and the intensity) only during the positive phase; and in the second group it was planned for the negative phase of the 23 day biological rhythm.

V. A. Peegel compared the relative best results in the positive phase of the biorhythm with those of negative phase and the critical days. The critical days had a negative influence on sport results and were a factor in the occurance of sport injuries.

In order to use biological rhythms for managing training it is necessary that coaches know how to set-up a biological chart in which the three cycles are depicted (physical, emotional and intellectual) as calculated from the athlete's date of birth. The biological cycles are then matched with the competition calendar and divided into preparation and competition periods. The positive influence of biological rhythms can, to a known degree, be utilized in planning large training loads.

Now we can already speak of some experiences where biorhythms have been used in sport practice. Thus, A. D. Olifirenko (Simferopolsky State University) in 1968 used biological charts in managing weightlifters' educational-training preparation. The achievements of these athletes were very noteworthy. For example, master of sport S. Vorobtsov trained by this method and was USSR (Ukraine, Ed.) champion four times. V. Ilyn, master of sport international class, two-time Ukrainian and 1980 USSR champion also used this method. Masters of sport A. Ukrainsky, E. Minyevich, G. Shikhatov, A. Artukov, V. Moiseyev and other lifters used biorhythms.

The designation of physical, intellectual and emotional rhythms needs further experimental corroboration. There is sufficient experimental material in favor of 24-hour, monthly and yearly rhythms, but the data concerning physical, emotional and intellectual biorhythms is extremely uncertain. The assumption to begin each rhythm precisely on the date of birth and not a day later nor a day early is arbitrary. Of no less fickleness is the assertion that the lengths of the positive and negative phases of each rhythm are equal: you see, in nature rhythms are characterized by high changeability, which is associated with external factors.

A number of scientists believe that biorhythms do not begin from the date of birth, but are genetically programmed and transmitted through heredity.

Chief of Moscow Institute of Medico-biological Problems, Professor B. S. Alyakrinsky says: "Adherents of the exogenic (external) origins of biorhythms believe that the organism is able to perceive fluctuations in conditions but needs some external jolt for this (say, the sudden rotation of the Earth on its axis arouses the 24-hour rhythm).

If one considers that there is not one organism, organ, tissue or cell which would not be subordinate to the rhythm's law, then one can conclude: rhythms are a form of movement of living material. In other words material exists in movement and movement is rhythmicity. Consequently, rhythms are genetically programmed and are transmitted through heredity, including rhythms even before birth.

This is corroborated by the fact that organisms deviate from the 24-hour rhythm when isolated from external conditions. It is interesting and important that each of them began life according to their own "personal" time-table, one's daily cycle is 23-hours others are 25 or 28. Inasmuch as all the tests were conducted under equivalent conditions (no perception of changes in day or night) then these differences can only be explained as differences in the genetic program. In other words, each (organism) has its own geneto-rhythm.

As regards to the usual terrestrial life then here we are subject to pheno-rhythm. This is the fusion of geneto-rhythm with external influences or differently, the geneto-rhythm adapts to the conditions of life.

The weekly, monthly, seasonal and yearly rhythms are known to science. In our laboratory we have worked up a conception (as yet this is still a working hypothesis) that all of these rhythms are interconnected and that the fixing of these interconnections protects the organism from over-load and over-strain. The sequential rise and fall in work-capacity, tension and relaxation protects the organism from different types and lengths of over-load and protects it from premature wear and tear.

Studies of the periodicity of 23, 28 and 33 day biorhythms are, from a scientific standpoint, quite groundless. Rhythms, which arise precisely from the moment man makes his appearance in the light, have not been discovered.

It is quite probably that these same rhythms of the inorganic world lead to such a notion as time. By observing the uninterrupted alteration of the surrounding realities -- such as the change from day to night or say the change of seasons, man adopted the notion of time as characteristic of the changes in the material world.

Data is available (A. V. Volkov, 1970; V. I. Karpenko, V. I. Shaposhnikova, 1973 and others) which indicates that an athlete's work-capacity changes not only during a 24-hour period but over several days, as well. Indices of representatives from different types of sports (gymnasts, soccor players, biathlon athletes) such as energy, plastic exchange, co-ordination and motor qualities, change periodically according to an individual time span, from 12 to 16 days (an average of 14 days). In the opinion of the authors mentioned such periods are characterized by constant sequential phases of rising and falling of the activity level of the metabolic processes. It should be noted, that periodic alterations indicated in the activity of the organism are of a hidden character. In order to expose these regularities it is necessary, during the basic exchange state (upon awakening in the morning), to record one or several of the indices of interest (for example body temperature, bodyweight, dynamometria, time of a motor reaction, explosive leg strength, pulse and so forth). The figures are then subjected to statistical analysis (the sliding means method, auto-correlational analysis, etc.), a curve is obtained by plotting on a graph and subjected to analysis.

At the present time, it is rather complicated to put the theories of biorhythms into the practice of athletic training. Sport results obtained in practice which would not seem to be of value, are subjected to analysis. This is why it is impossible to consider biological rhythm data as ready prescriptions for coaches in all living situations. The successful use of biological rhythms in training depends on the knowledge and skill of the coach. It is also important to take into consideration social factors (living conditions, studies, work, the athlete, etc.) when utilizing biorhythms.

In conclusion, it is necessary to emphasize that primitive attempts to utilize biorhythms, speculation on the ideas of biorhythmology, division of the phases of the rhythms into "fortunate" and "unfortunate" is all right and not harmful. Sport science can not benefit from nor attempt to "close" the problem of biorhythms.

V. Means of Recuperation for Weightlifters

One's bodyweight is an important factor in the control over the development of sporting form.

Weightlifters compete in different weight classes. They have to keep their bodyweight within a certain range over many years of training. This, to a large degree depends on the optimal water-salt volume in the organism.

Water is 65% of a person's bodyweight. For example, a person who weighs 70 kg has 46 kg of water in his body. His skeletal musculature contains 22 kg of water. When one frequently loses weight for competition it is necessary to remember that a 10% loss of water will cause serious difficulties and a loss of 20-25% can result in death. Oxidation forms part of the water within the organism. For example, the oxidation of 100 grams of fat forms 107 grams of water, 100 grams of starch -- 55 grams of water and the oxidation of 100 grams of protein forms 41 grams of water.

A person requires close to 2.5 liters of water a day. There is a definite equilibrium within the organism between the intake and excretion of water and salt (water-salt balance). Important links in the regulation of water-salt exchange are the so-called water-salt depots -- organs in which the organism holds reserves of fluid. The functions of the so-called water depots are carried out by the skin, the liver, the spleen and other organs. They absorb excess water and salt entering the organism and when there is an insufficient intake of water and salt they replenish the existing deficit.

Significant losses of water and salt usually occur during hard muscular work. Water loss is the result of increased perspiration and can reach 1-2 liters in one training session. Water loss during exercise can be determined by the loss in bodyweight, the main cause of which is increased perspiration. A number of unfavorable changes occur within the organism as a result of fluid loss: a decrease in the quantity of blood circulating and an increase in its viscosity, increased heart rate, shortness of breath, rise in body temperature, fatigue and so forth.

After training and significant loss of water and electrolytes weightlifters are thirsty and for the most part consume a lot of fluids. From what has been discussed it is clear that it is important for weightlifters to pay close attention to water intake, especially in training and during competition.

What should be the diet of lifters in different weight classes? Athletes in the 52-67.5 kg classes are advised to consume 1.5 liters of fluids per day. The athletes at these bodyweights should not allow their weight to exceed 1.5 to 2 kg over the class limit so that loss of weight before competition will not have unfavorable consequences. Athletes in the middle and middleheavyweight classes should consume 2 liters of fluids daily. The upper limit of their training bodyweights should not exceed 2 kg over the class limit. Athletes in the heavyweight classes required 2.5-3 liters of fluids daily. Electrolyte beverages are best for quenching thirst (for example, sweet bread-kvas mixed with baker's yeast, salts, vitamins and lactic acid). Vegetable broth, juices and tea, especially green tea contain electrolytes. Green tea more than water furthers the secretion of gastric juice, increases salivation and relieves dryness in the mouth. Diuresis and perspiration are less after drinking tea than after consuming water. Cherry broth is a good thirst quencher. Drinking vegetable juice and sweet tea an hour before training decreases dehydration during hard training. At night, before bed, it is advisable to drink 200 ml of water mixed with lemon; this normalizes the working of the heart and speeds the onset of sleep.

The water-salt regimen has great significance during weight loss. One of the basic causes of overweight is the accumulation of surplus fat as a result of the excessive intake of food. If one begins "cutting" weight in advance then the caloric intake should be decreased. Fluids should be decreased by 0.6 to 1 liter per day during the weight-loss period. The limitation of fluid intake stimulates the oxidation of body fat; and the organism obtains its water from this process.

One needs to limit the use of fluids with food including mineral water, coffee, tea and so forth. However, one should not eliminate vegetable and meat broths, soups, and bouillons from the first courses because they contribute to the secretion of gastric juices and digestion. During weight-loss raw fruits and vegetables are recommended. Meals should not be heavily spiced because this increases thirst. Along with restricting fluids, one should also decrease table salt. This accelerates the excretion of water from the body.

An increase in the volume of the training load leads to a significant increase in energy expenditure which in turn raises caloric requirements. Important features of an athlete's diet are larger (for them) than normal amounts of vitamins and mineral salts.

In addition to supplying sources of energy, vitamins, salts and water, a weightlifter's diet should contribute to an increase in work-capacity and accelerate recuperation after hard training. Weightlifting characteristically involves brief momentary, significant physical loads. An athlete's daily energy expenditure is 3500-4500 calories.

A weightlifters' diet should be subject to a certain regimen both during training camps and competition as well as at home. The distribution of food depends upon what time of day the basic part of the training load takes place.

If the workout occurs between breakfast and lunch, then breakfast should consist primarily of carbohydrates and contain sufficient calories (up to 25% of the daily requirement). It should not be large in volume and be easily assimilated. Dinner should supply the athlete's expenditure of calories during the training sessions. The energy value of supper is about 25% of the daily requirement. Cottage cheese and its by-products, fish and porridge can be recommended at supper. Products which require a long time to digest should not be eaten at dinner.

After dinner, before bed, it is good to drink a glass of kefir (cultured milk, Ed.) or sour milk which supply additional sources of protein. Besides this, these products improve digestion and contain micro-organisms which suppress the growth of pathogenic and putrefactive microbes in the intestines. It is expeditious to eat 5-6 times per day when training once or twice daily. Nutritional means of recuperation are also used (products and drinks of high biological value); the energetic value of which reaches 20% of the general caloric consumption. For example, for six meals per day breakfast would contain 30% of the calories, the recuperative means 4%, nourishment after the workout - 4%, dinner - 25%, supper - 28% and additional nourishment - 10%.

The following products can be included in the daily ration of weightlifters (4,500 calories):

Meat and Meat Products	300 grams
Fish	100 grams
Milk	300 grams
Cottage Cheese	150 grams
Cheese	30 grams
Eggs	2
Butter	70 grams
Margarine	15 grams
Grains (buckwheat, rice)	80 grams
White bread	300 grams
Black bread	300 grams
Potatoes	400 grams
Fruit	500 grams
Sugar	200 grams
Tea, Coffee	10 grams

This diet contains 180 g of protein, 1,345 g of fat and 725 g of carbohydrate. It is necessary to remember when a weightlifter is controlling his weight that milk, bouillon, a soft-boiled egg, cocao, tea, and black coffee remain in the stomach 1-2 hours; boiled fish and veal, a hard-boiled egg, coffee and cocao with milk or cream - 2-3 hours; boiled chicken, boiled beef, bread, apples, rice porridge, potatoes and cabbage - 3-4 hours; hot (meat, fowl), herring, pea-pudding, stewed beans and fats - 4-5 hours.

Meat is an important source of valuable protein; the various types of meat and fowl contain 14 to 24% protein. The reason the biological value of fish protein is no lower than that of meat protein is because the amino-acid composition is similar; fish protein is even slightly easier to assimilate. The amino-acid content of egg protein can be optimal for the body's requirements.

An athlete's mineral requirements are greater -- phosphorus, calcium, iron and magnesium. Milk, sugar (lactose), cottage cheese, sour cream and eggs are the basic sources of calcium. There is a lot of phosphorus in milk and milk products, eggs, meat, liver, fish, oat and buckwheat meals, bread as well as in legumes. Liver, meat, legumes, wheat and rye flour, oatmeal, peaches, apples, plums, etc. are sources of iron. Important sources of magnesium are breads, grains and legumes.

A weightlifter's diet should contain less calories, during the skillful weight-loss than during training. This contributes to the involvement of fat reserves in the exchange of substances. Daily caloric intake during the regulation of bodyweight is reduced by 30-45 calories per kilo of bodyweight.

The following composition of the daily diet is recommended for weight loss (per kilo of bodyweight, daily): protein - 2.4-2.5 grams, fat - 1-2 g, carbohydrates - 4.0-4.5 g. In individual cases the amount of fat can be reduced. The basic portion of the diet should be comprised of vegetables, fruits as well as lean meat and fish.

Raw vegetables are large in volume, low in calories and quickly satisfy hunger. Raw vegetables and fruits (especially apples) are low in sodium chloride and relatively rich in potassium which furthers the loss of water from the body. In selecting an assortment of products, one should avoid fruits which contain a lot of sugar (raisins, dates, bananas) and also slightly decrease the ration of potatoes which contain a lot of starch.

The amount of table salt in the diet should not exceed 5-8 grams, including the salt contained in foods. Fluids are restricted to 0.5 to 0.6 liters per day. This includes a cup of bouillon (at dinner), 1-2 glasses of milk, kefir or acidolphilus (breakfast, supper).

The decrease in caloric intake for weight-loss should be combined with other means of losing weight (dry sauna, steam bath, diuretics, laxatives, appropriate exercise).

Weight control begins ahead of time. It is regulated gradually up to the moment of competition.

Use of Food Supplements in the Rehabilitation System of Weightlifters

The domestic industrial sector has made available a number of food supplement products and pharmacological preparations which are for the athlete's recuperative system after large training loads; they replace substances lost.

Pharmacological preparations are divided into three groups:

1) Preparations which amplify protein synthesis and energy exchange (potasium orotate, inozin, carnitin, muscle-adrenal preparations, metiluratsil, etc).

2) Preparations with energy actions (panagin, glutamic acid, calcium lactate, lecithin, aminalon).

3) Adaptogenic preparations (extract of eleutherococcus liquid, sap, polytabs, etc).

Athletes should use vitamin supplements (aerovit, decamevit, undevit, geksavit, asnitin, tetravit, pentovit, etc).

Pharmacological preparations promote muscle growth as well as enabling the athlete to recuperate faster after large training loads. However, use of these preparation in large quantities will have a negative influence on the body's vital activities. There have been instances where athletes have died from the use of these preparations. The use of hormonal preparations or their synthetic analogues can not be condoned from a moral-ethical standpoint (A. N. Vorobyev, 1977). The Physical Culture and Sport Committee of the USSR Soviet Ministries and the IOC categorically prohibit the use of doping, anabolic means.

The dosages of pharmacological preparations, vitamins and food supplements for athletes specializing in speed-strength types of sports have been established.

Potasium orotate is prescribed: 0.5 grams per day for up to 70 kg of bodyweight, 0.75 for up to 80 kg, 1 g for up to 100 kg and 1.5 g for over 110 kg (during periods of intense training - 20-25 days). Potasium is usually prescribed in combination with muscle-adrenal preparations (MAP); MAP dosage is 30 g per day.

Inozin can be prescribed along with MAP. Inozin dosage is

0.4 g per day for up to 70 kg bodyweight, 0.6 g for up to 100 kg and 0.8 for over 100 kg (2-3 times per day for 15 days).

Carnitin is prescribed accordingly - 50 mg per 1 kg of bodyweight (once a day dosage), Cobalamin is 1 mg per 10 kg of bodyweight (daily). Both of these preparations as well as tocopherol acetate (vitamin E) is prescribed during the competition period. Tocopherol acetate is used for a period of 15-16 days at a dosage of 50 mg per day.

In addition to the aforementioned, preparations with energetic actions can be prescribed: Glutamic acid (1 gram per day together with a complex of potasium orotate and inozin); one tablet, 3-times per day of panagin; 100 mg 3-times per day of lecithin beginning 3-4 days before competition and on the day of competition give this to the sportsman at the preliminary examination; one teaspoon of extract of eleutherococcus fluid is administered 30 minutes before meals, preferably before breakfast.

Preparations associated with speeding up the sportsman's recuperation after large training loads are:

Ginsing extract and liqueur are recommended for large physical and psychological loads as well as for over-fatigue. Fifteen to twenty-five drops of a 10% solution of Ginsing liqueur is administered three times per day dissolved in a small quantity of soda for 10-15 days;

Chinese tea - obtained from a fruit bush which contains ethereal oil, organic acids, carbohydrates, vitamin C and other substances. It has a general-tonic action (20-30 drops per day for 2-4 weeks).

Clove liqueur and liquid extract is utilized in medicine for root and tooth lacerations, it contains ethereal oil, resins and salts of organic acids (20-30 drops, 2-3 times per day before eating).

Pantokrin - liquid spirit extract from the Siberian stag, the izubrya and the spotted dear(30-40 drops, 2-3 times a day before meals).

Vitamin preparations are prescribed as needed:

Calcium pantothenate - participates in carbohydrate and fat metabolism (0.1 g per day).

Lipotropic acid - plays an important role in the process of energy formation within the organism, participates in the regulation of lipid and carbohydrate metabolism. One 20 mg tablet combined with calcium pantothenate;

Niacin - one 5 mg tablet per day, more with lipotropic acid and calcium pantothenate;

Thiamine (Vitamin B_1) and its analogues - thiamine bromide and thiamine choloride. Take one 5 mg tablet per day, additional -- in a multi-vitamin tablet;

Ascorbic Acid - has strong recuperative qualities, participates in regulation of the oxidation-restoration processes (0.25 g, 2-4 times per day). Rosehip fruit, syrup and vitamin fortified tea contain a lot of ascorbic acid.

One should be guided by the following rules when administering pharmacological preparations to athletes:

1. A complex of pharmacological means and not separate preparations which regulate the metabolic processes in all of the organism's links is best. A doctor should determine these complexes by taking into consideration information from the coach about the character of the sportsman's training loads in a given period.

2. The minimal daily dose of a preparation should be prescribed on the days with the largest loads and only on the rest days is the dosage increased to maximum. In this way, the use of the preparation before training does not block its influence on the organism and the training gives the planned effect.

3. A complex of means should be individually selected for each sportsman based on data from medico-biological observations concerning the adaptation of the organism to loads, accustomed and resistance to preparations; the necessity of prophylactic therapy for the athlete's chronic diseases.

4. It is necessary to change the complex of preparations during the yearly training cycle since one grows accustomed and a resistance to any of them increases.

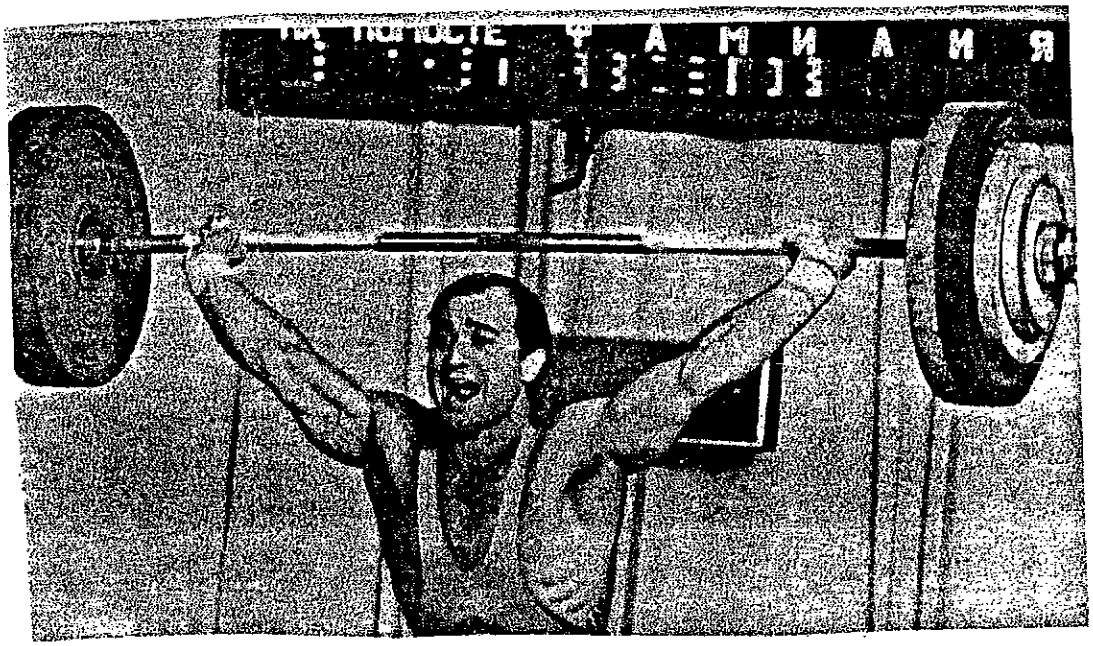
5. It is not adviseable to use the pharmacological means throughout the entire year's training cycle. It is expeditious to not use them during the transition period; and in the prepatory

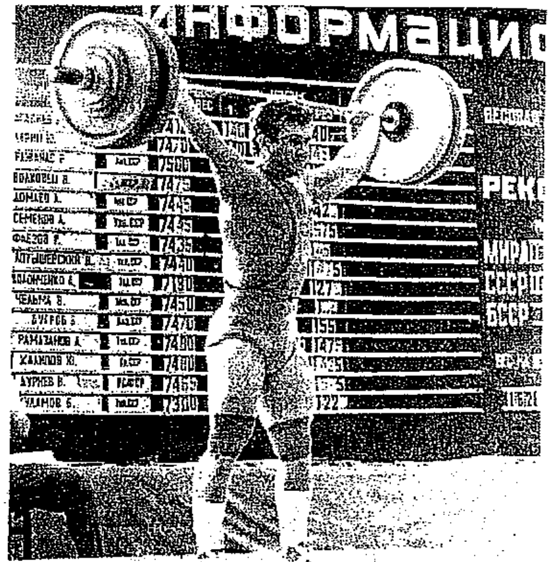
period -- take preparations which improve recuperation only in the "shock" microcycles. It is inappropriate to use preparations that increase work-capacity during this period.

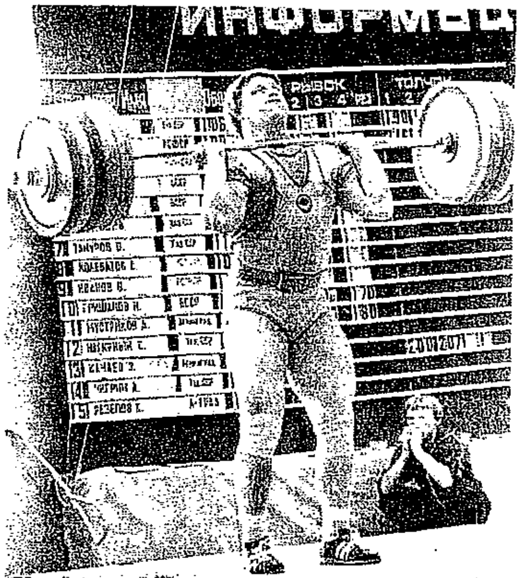
As to the aforementioned food supplements:

The subliminal product (SP-11) is 44% protein. It is easily assimible and is high in biological value; take 50 g a day in two applications - one hour before and one hour after training;

"Olimp" liver protein (37% protein) "Shokoladny" (28.5% protein); "Kofeiny" (44%); "Fruktovy" (44.9%) contain mineral salts and retinol (Vitamin A), thiamine (Vitamin B_1), pyridoxine (Vitamin B_6), ascorbic acid (Vitamin C), Nicotonic acid (Vitamin PP), tocopherol acetate and others.



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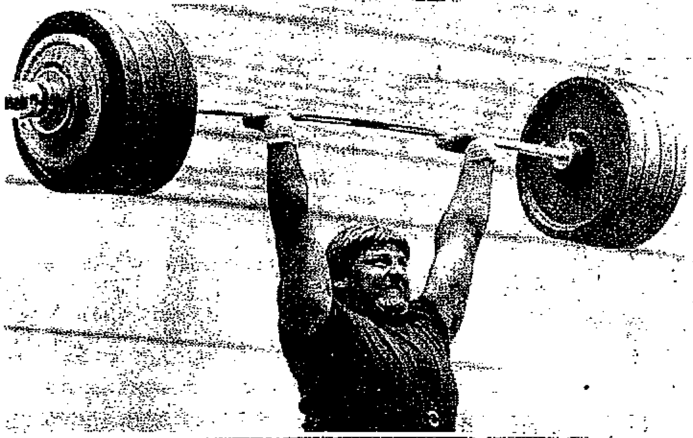

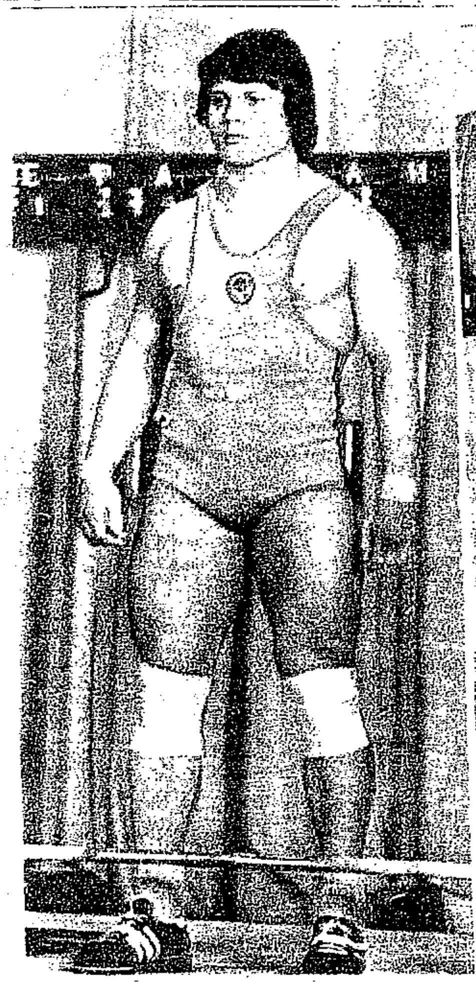

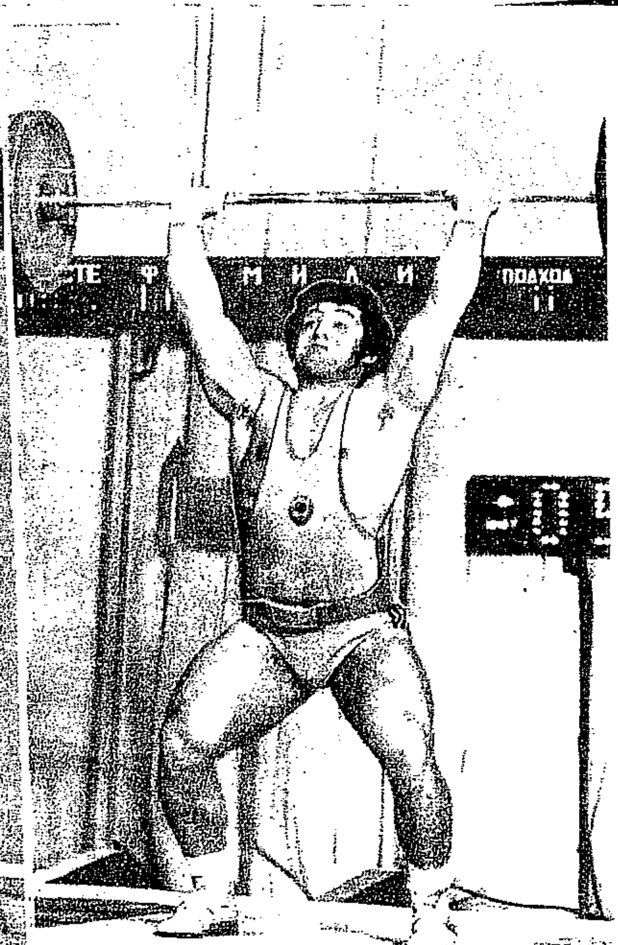
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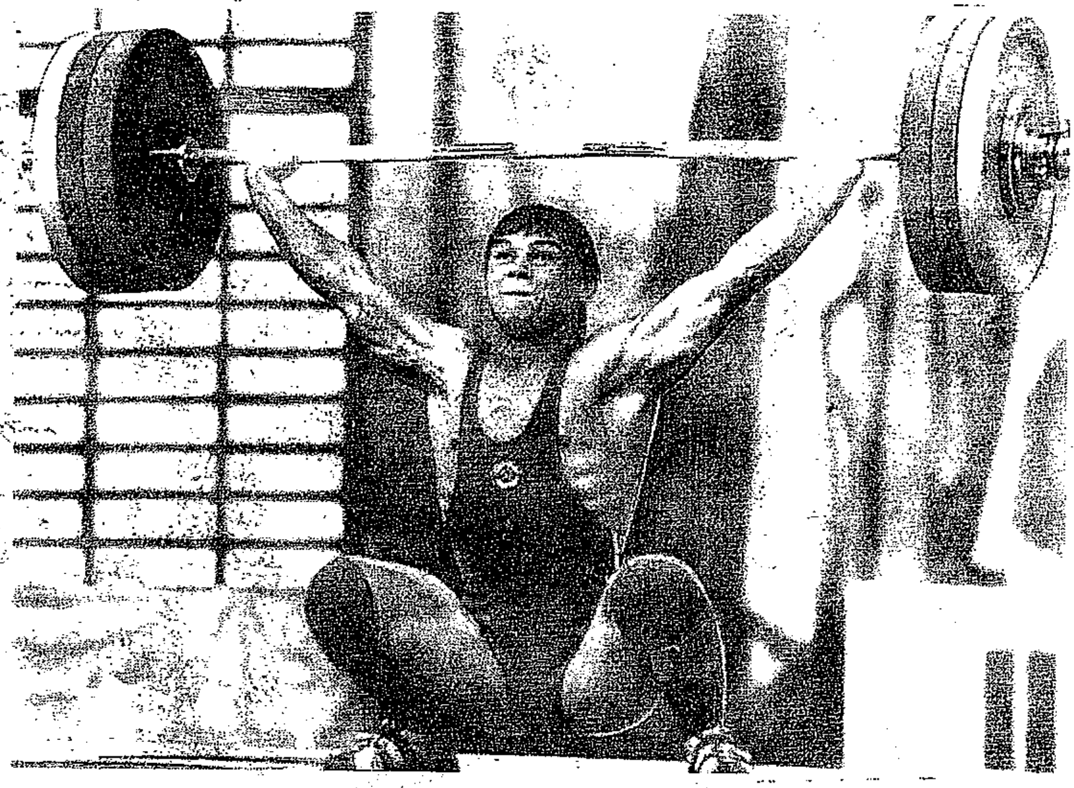

«ЖЕЛЕЗНОЙ ИГРЫ