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## Influence Of Hypo-Caloric Diet On Absolute And Relative Strength Of Elite Male Bodybuilders` While Preparing For The Competition.

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### ABSTRACT

Bodybuilding is characterized by sportsmen aesthetic and ability to develop lean body mass. Bodybuilders prepare for a competition using strict diet and resistance training. In these conditions, sportsmen tend to lose body mass (BM), hence, ability to perform absolute strength is mitigated. Therefore, changes of elite bodybuilders` body mass (BM), lean body mass (LBM), fat mass (FM), fat percentage and 1 repetition maximum (1RM) results in bench press (BP) and dead lift (DL) were tracked. Output of absolutely (AS) and relative (RS) strength were obtained. Furthermore, the number of repetitions in pulling up was measured. Twenty one elite sportsmen used hypo-caloric diet (3,5 g/kg BM of protein, 1 – 1,5 g/kg BM of carbohydrates, 0,5 – 1 g/kg BM of fat) during 7 weeks of preparation. The results showed significant decrease in BM ( $p < 0,001$ ), FM ( $p < 0,001$ ) and LBM ( $p < 0,001$ ). Although absolute strength tended to decrease in bench press ( $t=9,5$ ,  $p < 0,001$ ) and in dead lift ( $t=8,54$ ,  $p < 0,001$ ) while losing body weight, relative strength had grown both in bench press ( $t=11,4$ ,  $p < 0,001$ ) and dead lift ( $t=8,0$ ,  $p < 0,001$ ). It has been also showed that results in pulling up improved due to decreasing of BM. The article offers important findings regarding bodybuilders` diet and its influence on strength results. Sportsmen and coaches should consider the reported information when developing a plan of preparation to the competition.

**Keywords:** Bodybuilding, body mass, absolute strength, relative strength, preparatory period, competition.

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**INTRODUCTION**

Bodybuilding is a kind of sport where athletes are judged by their aesthetics [[6],[13]]. One of the main goal in bodybuilding is muscle mass growth and reduction of body fat percentage. Sportsmen’s muscular proportion should meet the demands of specific weight category and class to show advantages and to hide disadvantages. Preparation in bodybuilding is divided into two phases – ‘off-season’ and ‘pre-contest’ [[12]]. During off-season period adequate energy intake is essential in order to gain muscle mass, the same refers to protein consumption. Muscle consist of protein and water.

In order to achieve better body composition, bodybuilders and their coaches use strict diet, resistance and cardio training. Although most of the sportsmen employ a coach to design a nutrition plan, training program and posing, these recommendations often have insufficient scientific support. Low-carbohydrate diet is the most frequently used among competitive bodybuilders [[2]]. Nevertheless, bodybuilding workouts depend on muscle-glycogen storage, so optimal balance of carbohydrate consumption through preparatory period must be met [[8]]. Researches [[1]] show that ingestion of 5-6 g of carbohydrate/kg/day is needed to maintain positive glycogen balance.

Preparatory period typically lasts 6-12 weeks dependently on sportsman’s condition. Bodybuilders and their coaches try to maximize fat loss and minimize muscle mass loss [[2]]. Study shows that it is unlikely to save muscle mass in negative energy balance due to the necessity to maintain sportsman’s training intensity and volume.

Strength is an important factor in many kinds of sport and very often sportsmen lose their body mass to compete in lighter weight class [[5]]. Hence, it is important to find most optimal ways to lose weight and maintain sports performance. To compare strength ability of different people, who have different weight, relative strength is to be calculated. Relative strength (RS) can be found via equation:  $RS=AS \cdot BM^{-1}$ , where AS is absolute strength, BM – sportsman’s body mass. It is well known, that decreasing of athletes` BM leads to decreasing in absolute strength (AS) [[7]].

To the authors` knowledge, there is no data examining alterations of lean body mass and relative strength among elite male bodybuilders during preparatory period. Thus, the aim of this investigation is to analyze changes of absolute and relative strength, BM, LBM and fat percentage, which occur due to hypo caloric diet throughout preparation.

**MATERIAL AND METHODS**

The subjects were 21 elite male bodybuilders who won regional competition or took 1-5 places in the championship of Ukraine. All subjects were injury free for 9 months prior to participation in the research and denied using substances, which can influence strength. Physical characteristics of participants are presented in table 1.

**Table 1: Physical characteristics of elite Ukrainian bodybuilders (n=21)**

	mean	±	SD	min	max
Height, sm	175,1	±	5,1	166,0	184,0
Weight, kg	88,6	±	11,7	74,0	121,0
Age, year	26,7	±	4,7	19,0	34,0
BMI, kg/m2	28,8	±	2,7	25,9	37,3
Fat,%	16,4	±	2,7	12,0	22,0
FM, kg	14,8	±	4,2	9,4	26,6
LBM, kg	73,8	±	8,1	62,9	94,4

BMI – body mass index; FM – fat mass; LBM – lean body mass

The study was conducted in accordance with the Helsinki Declaration. The study was approved by the ethics committee of the Kharkov State Academy of Physical Culture (Ukraine). All subjects were informed about the research aim and methods and agreed to participate in the research.

## Measurement methods

The characteristics of body composition were measured with body analyzer scales BEURER BG 17 with accuracy of 100g every week in the same day and at the same time for each sportsman. All measurements took place on an empty stomach.

## Measurement of absolute and relative muscle strength

The bodybuilders performed a brief warm up with 10 minutes walking (speed  $7\text{km} \cdot \text{h}^{-1}$ ) and 2-3 sets of 5-8 repetition at 50-60% of their 1 RM. The participants began 1 RM. testing five minutes after warm up. All subjects were allowed to make three attempts to obtain the 1 RM load. The sportsmen were given manual of the correct technic for every lift. Relative body strength was calculated by dividing results in BP and DL by total body mass ( $RS=1RM \cdot BM^{-1}$ ).

## STATISTICAL ANALYSES

Collected data was processed via Statistica 10.0 to obtain mean value and standard deviation. A Shapiro-Wilk test was used to analyze normality and homo scedacity of the obtained data. One way, repeated measures analysis of variance (ANOVA) followed by Bonferoni's post-hoc test were used for comparisons between BM, LBM, BF weekly conditions. Depended t-tests were performed do determinate differences in BP, DL, pulling up performance. An  $\alpha$  priori level of significance was set at  $p \leq 0,05$ .

## EXPERIMENT PROCEDURES

The sportsmen were asked to measure their daily food intakes over preparatory period which lasted for seven weeks. Thereafter, food composition table were used to analyze each of the diet records. Total daily energy and macronutrient intake were calculated. The sportsmen in the study consumed 3,5 g of protein, 1 – 1,5 g of carbohydrates, 0,5-1 g of fat per 1 kg of body weight. Undulating model of periodization was used in the training process with accordance to Helms et al. Each muscle group was loaded two times per week, roughly 60-80 reps for the muscle group throughout one training session were done. Rest intervals were equal 1-1,5 minutes between sets.

## RESULTS

### Weight reduction during preparatory period

Weight, LBM, FM changes were observed during preparatory period which lasted 7 weeks. Results are shown in the figures 1-3. The most rapid changes occurred in fat percentage, however despite resistance training, significant reduction of LBM was found. It is likely that decreasing in LBM took place due to lack of kilocalories, which is detrimental to muscle growth.

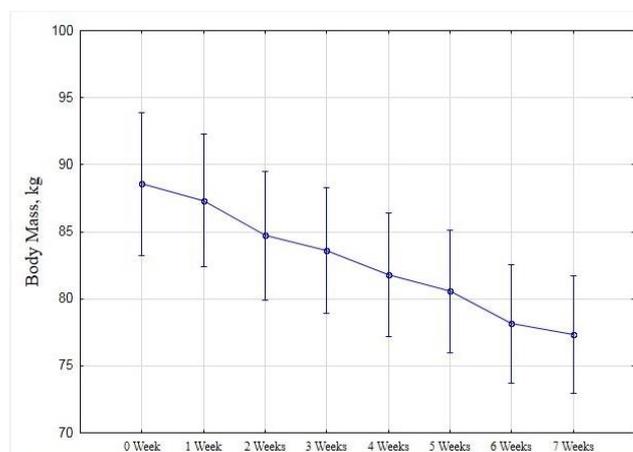


Figure 1: Bodybuilder's body mass (mean $\pm$ SD) at times (n=21);  $F=453, 68, p<0,001$ .

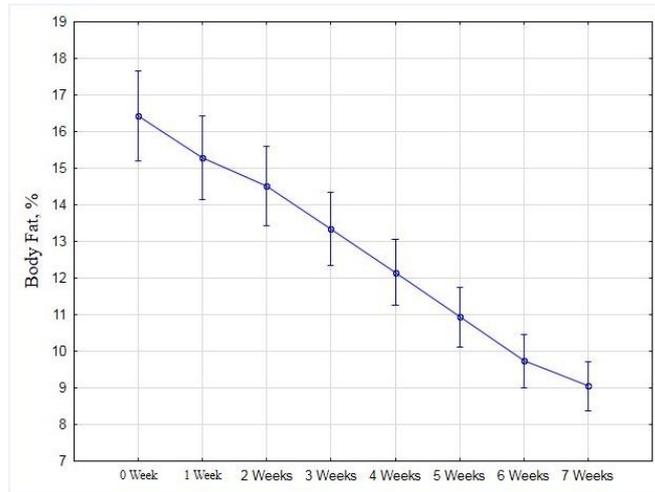


Figure 2: Bodybuilder's body fat percentage (mean±SD) at times (n=21); F=781, 00, p<0,001.

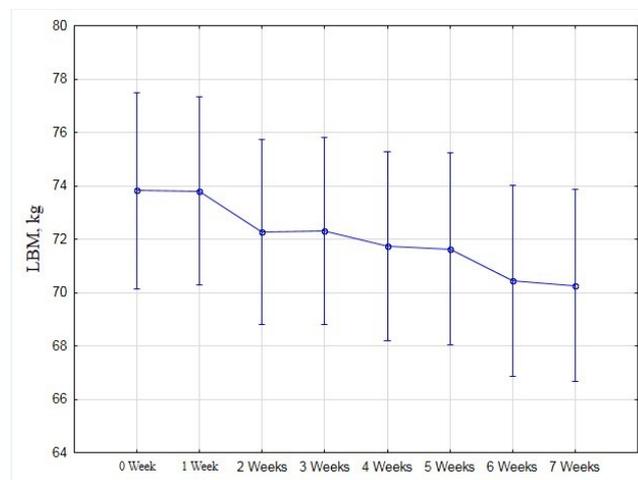


Figure 3: Bodybuilder's lean body mass (mean±SD) at times (n=21); F=143,16, p<0,001.

**Changes to absolute and relative muscular strength at the beginning and the end of preparatory period**

The alterations in physical fitness occur during preparation for competition among sportsmen. Table 2 shows significant decreasing of BP and DL results in 1 RM that take place in the competitive period in bodybuilding. As for pulling up, the sportsmen showed positive alterations in repetitions, which likely occurred because of reductions in BM.

**Table 2: Absolute muscular strength changes and analysis results in the beginning and the end of preparatory period (n=21)**

		mean	±	SD	t	p
Bench Press, kg	1st. Week	154,2	±	14,4	9,5	<0,001
	8th. Week	144,5	±	12,9		
Dead lift, kg	1st week	247,1	±	30,5	8,9	<0,001
	8th week	230,2	±	28,5		
Pulling up, reps	1st week	21,0	±	2,9	25,6	<0,001
	8th week	22,7	±	3,0		

Changes of relative sportsmen`s strength are depicted in the figures 4-5. Despite decreasing in absolute muscle strength, relative muscle strength was significantly increased in BP ( $t=11,4$ ;  $p<0,001$ ) and DL ( $t=8,0$ ;  $p<0,001$ ) over the course of preparation and dieting.

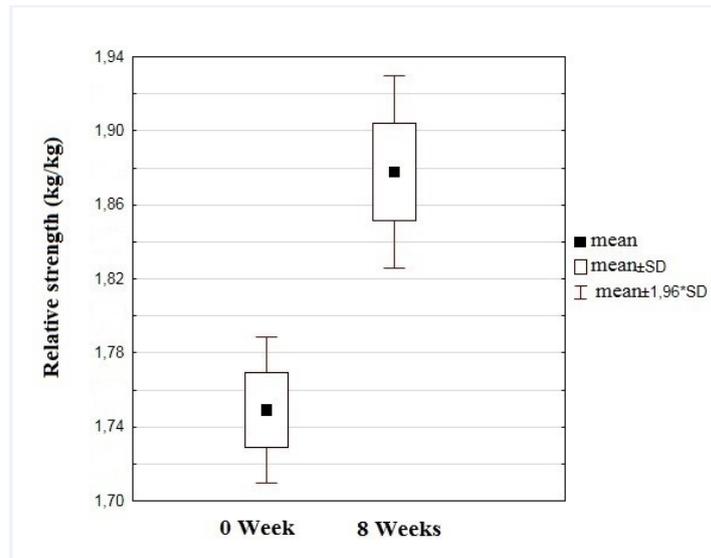


Figure 4: Relative muscle strength changes during preparatory period (n=21)

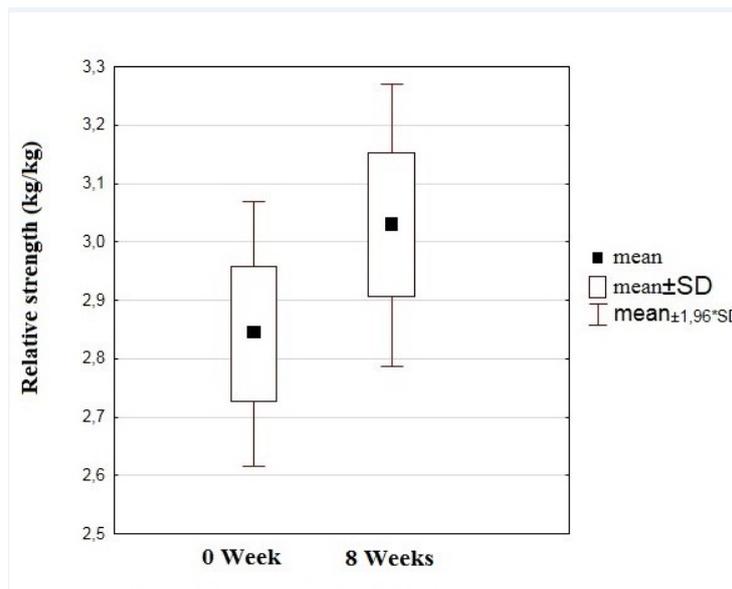


Figure 5: Relative muscle strength changes during preparatory period (n=21)

### DISCUSSION

In present study, we have demonstrated changes of body mass, body fat percentage, lean body mass and physical characteristics of elite Ukrainian bodybuilders during preparation period under the influence of hypo-caloric diet. The finding shows that the bodybuilders rapidly lost their fat mass; however, it was impossible to maintain level of lean body mass using hypo-caloric diet despite resistance training.

The major finding of the study is that although bodybuilders lost their results in the absolute strength tests, relative strength in dead lift and bench press was enhanced due to decrease in body mass.

Chappell et al. [[3]] investigated influence of dieting both for male and female competitive bodybuilders; preparation period lasted for 22±9 weeks. Male subjects who took prize places assumed 3±1

g/kg BM of protein at the beginning and  $3.3 \pm 0.9$  g/kg BM at the end; carbohydrate respectively were  $5.1 \pm 1.9$  g/kg BM and  $4.6 \pm 2.2$  g/kg BM; range of fat using was  $0.8 \pm 0.3$  g/kg BM –  $0.6 \pm 0.3$  g/kg BM. In our study diet strategy differed largely in carbohydrate level ( $1-1.5$  g/kg BM vs.  $4.6-5.1$  g/kg BM) due to the length of preparation period 7 weeks vs. 22 weeks.

Latella et al. [[5]] investigated relative strength in male and female power lifting. It was found that relative strength depends on BM, age and sex of athletes. It is greater for male compared with female ( $p < 0,001$ ), for lighter sportsmen and it tend to decrease with ageing. These factors proved our results and should be considered in sports where athletes need to increase relative strength or decrease body weight.

Different results were obtained by Garthe et al. [[14]], who explored influence of reducing elite sportsmen's bodyweight on their power-related performance. Although subjects in that investigation lost their body weight, they managed to increase their lean body mass and absolute strength 1 RM press, pull and squat. The aforementioned changes occurred in the group of elite representatives of different kinds of sports, which slowly reduced calorie content. The number of kilocalories and macronutrients accounted for protein  $1.6 \pm 0,4$  g/kg BW, carbohydrate –  $4.1 \pm 0,9$  –  $3.6 \pm 0,7$  g/kg BW, energy intake –  $2,409 \pm 622$  –  $1,940 \pm 482$  kcal. In bodybuilding it is difficult to lose fat mass and to enhance lean body mass simultaneously due to starting ratio between fat and muscle.

To the authors' knowledge, this is the first study that attempted to track changes of absolute and relative strength of elite bodybuilders who restricted caloric intake during competition preparation. This investigation may, therefore, provide a useful strategy for sportsmen who need to reduce their body mass before competition but save physical qualities.

## CONCLUSIONS

Bodybuilders employ strict dietary regime during preparation for competition that lasts in most cases 6-12 weeks dependently on initial performance of the particular sportsman.

It was previously suggested that bodybuilders' diet leads to negative alterations in health, mood and strength performance of athletes. Our study shows that despite decreasing absolute strength, relative strength enhances due to loss of BM mostly at expense of fat mass and slightly through the lean body mass.

These findings are likely to be of interest of sportsmen and coaches who involved in bodybuilding and strength-related kinds of sport. Future investigations should involve wider range of different level bodybuilders to understand changes in relative strength with respect to initial body weight and fat percentage.

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