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Anthropometric, Body Composition and Nutritional Profiles of Bodybuilders During Training

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ABSTRACT

The purpose of this study was to compare the anthropometric, body composition and nutritional profiles of 12 female and nine male bodybuilders during different stages of training. Noncompetitive data were collected six to 17 weeks prior to competition, and competitive data were collected 24 to 48 hours before competition. Percent body fat was determined using hydrostatic weighing. Regional deposition of subcutaneous fat was measured at six sites with skinfold calipers. Three-day diet records were recorded before each testing period. Differences between noncompetitive and competitive states for women and men were analyzed using two-way analysis of variance with repeated measures. Dependent t-tests were used to compare noncompetitive and competitive skinfolds for each gender.

There was a significant weight loss ($p < 0.001$) for both male (-5.4 kg) and female (-6.0 kg) bodybuilders, primarily due to reduction in fat weight. The relative fat loss for female bodybuilders (7.3 percent) was larger than that of the male bodybuilders (3.8 percent). The most marked decreases in subcutaneous fat levels were at the thigh (women) and abdominal (men) sites. With few exceptions, the nutrient intakes of the bodybuilders were either close to or well above the recommended values. In the competitive state, male bodybuilders consumed relatively larger amounts of carbohydrate and protein, but smaller amounts of fat. Female bodybuilders showed similar patterns for carbohydrate and fat, but their relative intake of protein was less in the competitive state. Our findings may help bodybuilders set realistic weight loss goals and plan nutritionally sound diets to minimize the loss of lean body weight.

KEY WORDS: Body fat, lean body mass, females, power athletes, weight training, skinfolds

Introduction

Bodybuilding is a demanding sport that requires year-round training to develop muscular shape, size, definition and symmetry. During the noncompetitive season, many bodybuilders gain body weight and body fat in order to lift heavier weights and increase training volume for the purpose of gaining muscle mass. In preparation for competition, bodybuilders use stringent exercise and diet programs designed to reduce body fat in order to attain maximum leanness and muscle definition for the contest.

Anthropometric and body composition profiles of competitive bodybuilders have been described in the literature (6, 7, 8, 9, 12, 19, 20, 21); however, in all but three of these studies (6, 9, 20) the training state (noncompetitive versus competitive) at the time of data collection was not reported. This is an important factor to consider in light of possible fluctuations in body weight, body fat and energy intake and expenditure during the noncompetitive and competitive stages of training.

In addition, there is a lack of information concerning nutrient intakes of bodybuilders (20, 21) and dietary modifications used to prepare for competition. Thus, the purpose of this study was to compare the anthropometric, body composition and nutritional profiles of female and male bodybuilders during the noncompetitive and competitive stages of training.

Methods

Twelve female ($\bar{x}$ age = 28.7 ± 7.2 years) and nine male ($\bar{x}$ age = 27.8 ± 5.7 years) bodybuilders volunteered as subjects for this study. The average height of the men and women was 177.1 ± 3.7 cm and 162.4 ± 3.2 cm, respectively. The average competitive experience of the male and female bodybuilders was 3.6 years and 2.2 years respectively. All but three of the subjects had prior experience competing in bodybuilding contests. Eighteen of the subjects held first, second or third place titles in city, state, regional or national contests, including Ms. Teen USA, Southwest Physique, Western America, Pacific USA, Mr. Hawaiian Islands, Mr./Ms. New Mexico, Lone Star and Mr./Ms. Albuquerque. Informed consent was obtained from each subject and the research was approved by the Human Research Review committee at the University of New Mexico.

Noncompetitive data were collected six to 17 weeks prior to the competition. The time between noncompetitive and competitive data collection varied because the subjects competed in different contests between April and August. All noncompetitive data, however, were collected before the subjects started dieting for their contests. Competitive data were collected 24 to 48 hours prior to the bodybuilding contest. To assess body composition, the subjects were hydrostatically weighed in a seated position using a Chatillon underwater scale. Subjects were instructed not to eat or drink eight hours prior to testing. Each subject was given 10 underwater weighing trials. The mean of the last three trials was used to calculate body density (13). Residual volume was measured out of water, in a seated position, using a closed circuit helium dilution method. Relative fat was calculated using the equation of Brozek, Grande, Anderson and Keys (2). Lean body weight (LBW) was calculated by subtracting the fat weight from the gross body weight.

To estimate the regional deposition of subcutaneous fat, the chest, abdomen, thigh, suprailiac, triceps and subscapula skinfold measurements were taken. All skinfold measurements were taken by the same experienced investigator whose internal consistency was reported to be excellent, with r's exceeding 0.99 (11). Three measurements at each site were obtained using Lange skinfold calipers (Cambridge Scientific Industries, Cambridge, Maryland). A fourth measurement was taken if any of the skinfold readings deviated by more than ± 1 mm. The average of three consistent readings was used as the criterion score for these variables.

To assess nutritional profiles, the subjects were asked to complete a diet record at home for three days prior to each test session and submit this information at the time of testing. Dietary information was collected on the 12 female subjects; however, data were available on only seven of the nine male subjects. A registered dietitian instructed the subjects on recording food and beverage intake using food models to illustrate portion size. The records were reviewed with each subject for clarification as needed. Information concerning drug usage and vitamin/mineral intake was obtained but was not included in the dietary analysis since we wanted to see whether or not the Recommended Dietary Allowances (17) were being met through usual food sources. Protein powders were included as part of the dietary analysis; however, amino acid supplements were not. Nutritional data were analyzed using the FOOD PROCESSOR I software package (ESHA Corporation, Salem, Oregon). The nutritional data in this program were compiled from 250 authoritative sources and contain the latest values available for all nutrients. For food items not included in the original data base, nutrient information was obtained from food labels and other sources (18) and added to the data base. Dietary data were coded and analyzed for 26 different nutrients. Results were averaged for each three-day period.

The contribution of the macronutrients to the diet was evaluated by comparing the percent of kcal from protein, carbohydrate and fat in the diets of males and females for non-competitive and competitive states. Additionally, vitamin and mineral intakes were expressed as the percent of RDA consumed (or other recommendations as appropriate) for purpose of comparison (1, 17, 22).

To analyze differences between the noncompetitive and competitive states for women and men, two-way analyses of variance (ANOVA) with repeated measures were used. The body composition dependent variables were body weight, LBW, fat weight and percent body fat. The dependent variables for nutritional data were kcal intake from protein, carbohydrate, fat and the percent of total kcal from protein, carbohydrate and fat. In addition, the percent of the RDAs for cholesterol, Vitamin E, thiamin, riboflavin, pyridoxine, niacin, ascorbic acid, calcium, iron, zinc and magnesium and the percent of estimated safe and adequate intake for sodium and potassium were analyzed. Dependent t-tests were used to compare the noncompetitive and competitive skinfolds for each gender. An alpha level of 0.05 was used for all significance testing. The alpha level was adjusted ($p < 0.008$) for the dependent t-tests using the Bonferroni technique to keep the experiment-wise error rate at 0.05.

Results

The anthropometric and body composition characteristics of the subjects are presented in **Table 1**. The reduction in body weight between noncompetition and competition was significant for both male (-5.4 kg) and female (-6.0 kg) bodybuilders ($p < 0.001$).

Results of the ANOVAs indicated that there was a significant decrease in both absolute fat weight ($p < 0.001$) and relative fat ($p < 0.001$) between the noncompetitive and competitive states. Although there was no significant difference in the fat weights of the women and men ($p = 0.583$), there was a significant gender by state interaction for relative fat levels ($p = 0.036$). The interaction reflects that the decrease in relative fat of the female bodybuilders (7.3 percent) was larger than that of the male bodybuilders (3.8 percent) (**Figure 1**).

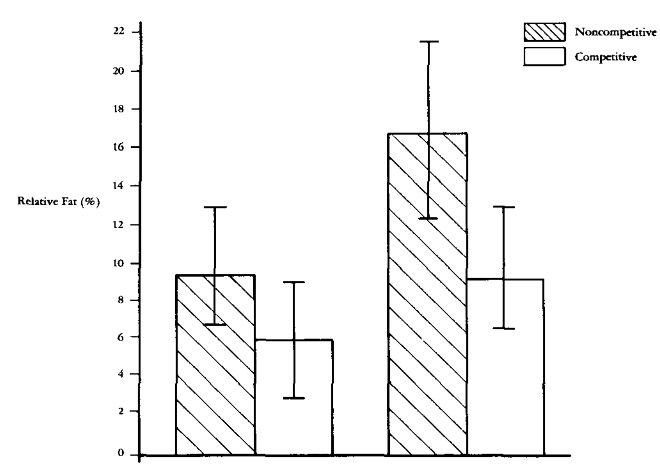

Figure 1. Comparison of Relative Fat Levels of Male and Female Bodybuilders for Noncompetitive and Competitive States.

The ANOVA also revealed that the gender by state interaction for LBW was not significant ($p = 0.647$); however, there was a significant difference between the LBW in the noncompetitive and competitive stages ($p = 0.006$). On the average, the LBW of the bodybuilders decreased 1.30 kg between the noncompetitive and competitive stages.

Comparison of the noncompetitive and competitive skinfold data revealed significant reductions at all sites except the thigh skinfold of male body builders (Table 1). The largest decreases in skinfold thicknesses for the women and the men were at the thigh (-7.6 mm) and the abdominal (-4.6 mm) sites, respectively.

The macronutrient intakes and distribution of kcal from protein, carbohydrate and fat are presented in Table 2. Due to greater intake of kcal by males in both competitive and noncompetitive states, the absolute amounts of protein, carbohydate and fat intake were greater for males than females.

Results of the ANOVA (Table 3) indicated a significant interaction between gender and state of training for the relative percentage of protein kcal in the diet ($p < 0.004$). Male bodybuilders increased the percentage of kcal from protein between noncompetitive (25 percent) and competitive (28 percent) states, whereas female bodybuilders decreased the percentage of protein kcal between noncompetitive (26 percent) and competitive (21 percent) states.

The percent of carbohydrate kcal in the competitive diets of the bodybuilders increased significantly from the noncompetitive levels ($p < 0.001$). The average percentage of kcal from carbohydrate was 52.5 percent in the noncompetitive and 68.6 percent in the competitive state. There was no significant difference in the average percent of kcal from carbohydrate for the male and female bodybuilders ($p < 0.197$).

In contrast, there was a significant reduction in the percent of kcal from fat in the diets of both men and women as they neared competition ($p < 0.001$). In the noncompetitive state, the average percent of kcal from fat was 22.9 percent. At competition, this value was reduced to 10.7 per-

Table 1. Anthropometric and Body Composition Characteristics of Bodybuilders for Noncompetitive and Competitive States.

		Noncompetitive		Competitive		Absolute	Relative
Variable		$\bar{X}$	SD	$\bar{X}$	SD	Change	Change (%)
Body Weight (kg)[a]	M*	91.5	9.2	86.1	9.5	-5.4	5.9
	F	58.3	5.2	52.3	4.5	-6.0	10.3
Relative Fat (%)[b]	M	9.7	3.1	5.9	3.2	-3.8	39.0
	F	16.8	4.5	9.5	3.3	-7.3	43.0
Fat Weight (kg)[c]	M	8.8	2.5	5.0	2.6	-3.8	43.2
	F	9.8	2.4	4.9	1.6	-4.9	50.0
LBW (kg)[d]	M	82.7	9.9	81.1	10.4	-1.6	1.9
	F	48.5	5.7	47.4	4.9	-1.1	2.3
Chest SKF (mm)[e]	M	5.0	1.0	3.5	0.5	-1.5	30.0
	F	7.1	2.5	4.0	0.9	-3.1	43.7
Abdominal SKF (mm)	M	10.7	3.0	6.1	0.8	-4.6	43.0
	F	11.9	3.4	6.2	1.7	-5.7	47.9
Thigh SKF (mm)	M	7.2	2.6	5.1	0.8	-2.1	29.2
	F	19.2	4.2	11.6	3.8	-7.6	39.6
Suprailiac SKF (mm)	M	6.8	1.3	4.8	0.7	-2.0	29.4
	F	8.2	3.7	4.4	0.9	-3.8	46.3
Triceps SKF (mm)	M	4.7	1.1	3.4	0.6	-1.3	27.7
	F	9.9	2.6	6.5	2.2	-3.4	34.3
Subscapula (mm)	M	11.9	1.8	9.2	1.3	-2.7	22.7
	F	11.2	3.2	7.6	1.9	-3.6	32.1

*n = 9 for males (M); n = 12 for females (F)
[a]significant gender by state interaction for body weight: $p < 0.001$
[b]significant gender by state interaction for relative fat: $p = 0.036$
[c]significant main effect of state for fat weight: $p < 0.001$
[d]significant main effect of state for LBW: $p = 0.006$
[e]with the exception of thigh SKF for males, all differences between noncompetitive and competitive SKFs were significant: $p < 0.008$

cent, on the average. There was no significant difference in the average percent of kcal from fat for male and female bodybuilders ($p < 0.223$).

The intakes of selected vitamins and minerals are presented in **Tables 3** and 4. For most of these nutrients, the average values represent more than 100 percent of the recommended value of the nutrients in both competitive and noncompetitive states. In the noncompetitive state, only the zinc intake of females was below two-thirds of the RDA. In the competitive state, the mean calcium, iron and zinc intakes of the female bodybuilders were below two-thirds of the RDA, and the calcium intake of the male bodybuilders was below two-thirds of the RDA.

Results of the ANOVA indicated significant gender by state interactions for several vitamins and minerals. Male bodybuilders decreased the mean intakes (expressed as a percent of RDA) of riboflavin ($p < 0.038$), calcium ($p < 0.013$), zinc ($p < 0.014$) and iron ($p < 0.02$) significantly more than female bodybuilders as they prepared for competition.

In addition, the main effect for training state was significant for selected vitamins and minerals. Overall, the percentages of recommended amounts for cholesterol ($p < 0.009$), Vitamin E ($p < 0.003$) and sodium ($p < 0.001$) were significantly less at competition compared to noncompetition for the bodybuilders.

The main effect of gender was also significant for selected vitamins and minerals. Male bodybuilders consumed, on the average, significantly greater relative amounts (expressed as percent of RDA) than female bodybuilders for Vitamin E ($p < 0.05$), pyridoxine ($p < 0.032$), sodium ($p < 0.01$), potassium ($p < 0.002$), magnesium ($p < 0.003$) and cholesterol ($p < 0.004$).

Discussion

Both male and female bodybuilders are lean athletes who have low relative fat levels in both noncompetitive and competitive states. The average relative fat of the male bodybuilders at competition (5.9 percent) was lower than that reported by other investigators (6, 7, 9, 12, 19, 20, 21) for regional, national and international caliber bodybuilders (7.2 to 9.9 percent). Likewise, at competition the women had an average relative fat level (9.5 percent) which was 4 to 5 percent lower than that typically reported for female

Table 2. Selected Nutrient Intakes and Energy Distribution of Bodybuilders for Noncompetitive and Competitive States.

Variable		Noncompetitive $\bar{X}$	Noncompetitive SD	Noncompetitive %RDA($\bar{X}$)[a]	Competitive $\bar{X}$	Competitive SD	Competitive %RDA($\bar{X}$)
Energy (kcal)[c]	M[b]	3590	1159	133	2331	259	86
	F	1630	550	82	1453	652	73
	Total Group	2352	1256	100	1776	686	76
Protein (g)[c]	M	215	59	300	163	59	245
	F	102	30	219	77	57	188
	Total Group	144	70	249	108	71	209
Carbohydrate (g)[c]	M	457	148	94	365	76	76
	F	208	60	63	261	112	79
	Total Group	300	157	75	299	111	78
Fat (g)[c]	M	110	71	97	32	18	29
	F	42	30	56	15	7	20
	Total Group	67	58	71	21	14	23
Cholesterol (mg)[c,e]	M	702	417	234	310	110	103
	F	320	317	107	152	121	51
	Total Group	461	394	154	210	138	70
Percent of Energy Intake							
Protein[d]	M	25	6		28	9	
	F	26	4		21	6	
	Total Group	25	5		23	8	
Carbohydrate[e]	M	52	11		63	10	
	F	53	11		72	11	
	Total Group	52	10		69	11	
Fat[e]	M	26	12		13	8	
	F	21	9		10	3	
	Total Group	23	10		11	5	

[a]Percent of RDA or other appropriate recommendation.
[b]n = 7 for males (M); n = 12 for females (F)
[c]significant main effect of gender: $p \leq 0.004$
[d]significant gender by state interaction: $p \leq 0.004$
[e]significant main effect of state: $p \leq 0.001$

Table 3. Selected Vitamin Intakes of Bodybuilders in Noncompetitive and Competitive States.

Variable		Noncompetitive			Competitive		
		$\bar{X}$	SD	%RDA ($\bar{X}$)[a]	$\bar{X}$	SD	%RDA ($\bar{X}$)
Thiamin (mg)	M[b]	2.84	.75	171	2.05	.73	125
	F	1.34	.54	119	3.41	7.66	310
	Total Group	1.89	.96	138	2.91	6.04	242
Riboflavin (mg)[c]	M	4.25	2.15	213	1.94	.70	98
	F	1.70	.72	125	1.44	.82	108
	Total Group	2.64	1.86	158	1.62	.80	105
Niacin (mg)	M	58.14	15.84	323	58.87	24.12	327
	F	32.44	11.34	250	29.84	16.39	230
	Total Group	41.91	18.01	311	40.54	23.77	300
Pyridoxine (mg)[d]	M	4.19	1.24	191	4.35	.71	198
	F	2.37	.72	118	3.07	2.27	154
	Total Group	3.04	1.39	145	3.54	1.93	170
Ascorbic Acid (mg)	M	154.14	93.98	256	171.13	81.61	285
	F	132.75	80.04	221	186.58	108.94	311
	Total Group	140.63	83.49	234	180.88	97.63	301
Vitamin E (mg)[d,e]	M	16.51	10.19	165	10.04	3.16	100
	F	7.94	4.03	99	5.48	2.76	68
	Total Group	11.10	7.91	124	7.16	3.62	80

[a]percentage of 1980 Recommended Dietary Allowance
[b]n = 7 for males (M); n = 12 for females (F).
[c]significant gender by state interaction: $p \leq 0.038$
[d]significant main effect of gender: $p \leq 0.05$
[e]significant main effect of state: $p \leq 0.003$

Table 4. Selected Mineral Intakes of Bodybuilders in Noncompetitive and Competitive States.

Variable		Noncompetitive			Competitive		
		$\bar{X}$	SD	%RDA($\bar{X}$)[a]	$\bar{X}$	SD	%RDA($\bar{X}$)
Calcium (mg)[d]	M[b]	2141.14	1672.61	267	416.14	208.54	52
	F	704.92	389.83	88	271.75	139.59	34
	Total Group	1234.00	1237.76	154	324.95	177.55	41
Iron (mg)[d]	M	28.63	9.80	286	18.84	7.11	188
	F	14.12	3.90	78	11.35	4.54	63
	Total Group	19.46	9.66	155	14.11	6.57	109
Magnesium (mg)[f]	M	631.14	203.99	180	494.00	146.31	141
	F	304.25	102.79	101	280.09	167.52	93
	Total Group	424.68	215.81	130	358.90	188.48	111
Zinc (mg)[d]	M	24.44	11.50	163	12.15	3.50	81
	F	9.31	4.13	62	7.47	4.80	50
	Total Group	14.89	10.53	99	9.20	4.84	61
Sodium (mg)[c,e,f]	M	3971.29	2475.37	132	1451.14	841.45	48
	F	1919.92	1203.89	64	603.08	457.83	20
	Total Group	2675.68	1990.42	89	915.53	735.36	31
Potassium (mg)[c,f]	M	6222.14	2481.32	166	5162.57	1276.09	138
	F	3028.17	1139.60	81	3561.00	1498.18	95
	Total Group	4204.89	2313.35	112	4151.05	1595.14	111

[a]Percentage of 1980 Recommended Dietary Allowance
[b]n = 7 for males (M); n = 12 for females (F).
[c]Percentages of Estimated Safe and Adequate Intake.
[d]significant gender by state interaction: $p \leq 0.014$
[e]significant main effect of state: $p < 0.001$
[f]significant main effect of gender: $p < 0.01$

bodybuilders (6, 8), but similar to that observed for another sample of female bodybuilders prior to competition (20).

The higher degree of leanness for the bodybuilders in our study may reflect differences in methodology, as well as in the caliber of the competitor. In the present study: (1) bodybuilders were tested 24 to 48 hours prior to competition; (2) residual volume for hydrostatic weighing correction was measured, not estimated; and (3) male bodybuilders were steroid users and female bodybuilders were steroid-free as self-reported. With the exception of Elliot, et al (6), Fry, et al (9) and Sandoval, et al (20), all other studies failed to mention the phase of training for their subjects at the time of data collection. In the Elliot, et al study (1) bodybuilders were tested within 72 hours after competition, (2) residual volume was estimated, not measured, and (3) male and female bodybuilders were steroid-free. Even with these methodological differences, the average relative fat for the male bodybuilders in their study (7.2 percent) is only slightly higher than our results (5.9 percent). However, the average relative fat for female bodybuilders differed by 5 percent. Immediately following competition, most bodybuilders return to off-season eating habits and tend to gain weight rapidly. This weight gain and change in body water may account, in part, for the differences in relative fat levels before and after a contest.

On the other hand, differences in methodology do not adequately explain the discrepancy in body fatness reported by Fry, et al (9) for male competitive bodybuilders. The average relative fat for their subjects was 8.48 percent. The subjects were also tested 24 to 48 hours prior to competition, and residual volume was measured using oxygen dilution procedures. Since no information concerning competitive experience and steroid usage was reported in this study (9), we cannot ascertain if the caliber of the bodybuilders in both studies was similar.

In preparation for the contest, it is very likely that part of the weight loss will be due to a reduction in LBW. In the present study the male bodybuilders lost, on the average, 3.8 kg fat and 1.6 kg LBW; whereas the female bodybuilders lost 4.9 kg fat and 1.1 kg LBW. Only five of the 21 bodybuilders either maintained or increased LBW during this time. These subjects lost, on the average, 5.0 kg fat prior to competition.

Seventy-five percent of the bodybuilders in our sample lost LBW in preparation for the contest. Comparison of the weight loss and dietary intakes of energy, protein, fat and carbohydrate for the two bodybuilders who lost the most LBW (-4.0 kg) and those who maintained their LBW revealed that the relative protein, carbohydrate and fat intakes of the two subgroups were similar. However, the energy intakes of the two bodybuilders who lost the most LBW were only 900 kcal per day compared to 1300 kcal per day for those who maintained their LBW. Thus, the greater loss of LBW may be due, in part, to the greater kcal deficit of some of the bodybuilders. Additional research needs to examine weight loss programs used by bodybuilders, so that the muscle mass developed during the noncompetitive season is not lost as a result of improper dietary regimes used in preparation for competition.

It is apparent that bodybuilders undergo dramatic changes in body composition in preparation for competition. To prepare for competition, bodybuilders need to reduce fat weight, especially subcutaneous fat levels. The largest skinfold thicknesses for the male bodybuilders, in both the noncompetitive and competitive states, were at the subscapula and abdominal sites. This observation is in agreement with skinfold data reported by other investigators for male bodybuilders (12, 21) and 31- to 43-year-old men (4). For male bodybuilders, the greatest absolute and relative change between noncompetition and competition was at the abdominal site (-4.6 mm or 43 percent). The smallest relative change was at the subscapula site. For female bodybuilders, the largest skinfold thicknesses were at the thigh, abdominal and subscapula sites. Freedson, et al (8) noted that the largest skinfold thicknesses were at the abdominal, triceps and subscapula sites for competitive female bodybuilders. The greatest absolute and relative skinfold changes for the female bodybuilders in the present study were at the thigh (-7.6 mm) and abdominal (48 percent reduction) sites.

In both the noncompetitive and competitive states, the largest skinfolds for male bodybuilders were on the trunk (subscapula and abdominal sites), whereas the largest skinfold for female bodybuilders was on the extremity (thigh). This finding supports the observation of Malina, et al (15) that the distribution of fat on the extremities relative to the trunk was significantly influenced by sex. The extremity/trunk ratio of female Olympic athletes was greater than that of their male counterparts, indicating more fat on the extremity relative to fat on the trunk. Also, male weightlifters, in particular, had lower extremity/trunk ratios than male athletes in other sports, suggesting more centrally distributed fat in weightlifters.

Both female and male bodybuilders significantly altered their dietary intakes from the noncompetitive to competitive state. When energy intakes were expressed relative to body weight, the intakes for men (39.84 kcal/kg) were greater than for women (28.13 kcal/kg) in a noncompetitive state. However, at competition, relative energy intakes were similar for men and women (27.43 kcal/kg and 27.69 kcal/kg, respectively).

The average proportion of kcal derived from protein, carbohydrate and fat showed different patterns across training states. The percent of kcal from carbohydrate increased 11 percent for men and 19 percent for women between noncompetitive and competitive states. The percent of kcal from fat was severely restricted in the competitive state, decreasing 13 percent and 11 percent, respectively, for men and women. Male bodybuilders increased the percent of kcal from protein by 3 percent at competition; however, there was a 5 percent reduction in the percent of kcal from protein for the female bodybuilders. Protein supplied, on the average, more than 20 percent of the kcal in the bodybuilder's diets. In the noncompetitive state, this was equivalent to 1.75 and 2.35 g protein/kg for women and men, respectively. In the competitive state the respective values were 1.47 and 1.89 g protein/kg.

There is considerable controversy regarding the optimum protein intake for athletes. Although the use of protein supplements is considered to be widespread in the bodybuilding community, only three of our subjects, all females, reported using protein powders (mean intake = 4 - 12 g per day). Amino acid supplements (mean intake = 1.5 - 8 g per day) were used by two male and four female subjects. The percent of kcal from protein in both the noncompetitive and competitive diets of the bodybuilders, which included protein supplements, slightly exceeded the suggested range of 12 to 25 percent for an athlete's diet (14). All of the male bodybuilders in our study reported using anabolic steroids; thus, their higher relative protein intake may be warranted. However, since none of the female bodybuilders reported using steroids, their high protein intake may be counterproductive to fat weight loss given that excess protein is converted and stored as fat in the body or used to meet energy needs (16). Moreover, excessive protein intakes are associated with high levels of calcium in the urine (10) and may contribute to dehydration and kidney strain.

With the exception of a few minerals, the nutrient intakes of the bodybuilders were either close to or well above recommended values. This was true for women despite their relatively low energy intake in both the noncompetitive (1630 ± 550 kcal) and competitive (1453 ± 652 kcal) states. At competition, the relative calcium intakes of male and female bodybuilders were low. The dietary intake of zinc and iron in the competitive state was also below the recommended levels for female bodybuilders. Other researchers have reported similar findings based on dietary surveys of women athletes (5, 23).

Practical Applications

This study documents the changes in anthropometric, body composition and nutritional profiles of bodybuilders as they prepare for competition. It is important to note however, that the male bodybuilders in the present study were steroid users. Undoubtedly, this affected their body composition and nutritional profiles. The dramatic increase in body weight, especially LBW, associated with anabolic steroids usually necessitates a large protein intake to maximize the effectiveness of the drug. With this in mind, our findings may be useful to competitive bodybuilders in setting realistic weight loss goals and planning nutritionally sound diets that minimize the loss of the lean body weight.

Knowing one's body composition may be useful in setting individualized weight loss goals and determining weight class categories for competition. Competitive weight can be estimated by measuring body weight and percent body fat in the noncompetitive state. Then, the athlete can set a safe and realistic relative fat/LBW goal and calculate the amount of fat loss needed to achieve that goal. For example, it may be reasonable for a female bodybuilder who weighs 54.5 kg and has 16 percent fat in the noncompetitive state to set a relative fat/LBW goal of 10 percent/90 percent. To calculate fat weight loss, her present LBW (45.8 kg) would be divided by her ideal percent LBW (90 percent), yielding a target body weight of 50.9 kg. It is assumed that all of the weight loss is due to a reduction in fat weight. Thus, she would need to lose 3.6 kg fat prior to the contest. Using the National Physique Committee's recommendations for weight class divisions, she would compete in the light weight category (< 114.5 pounds).

This method can be used effectively by any athlete who is interested in monitoring his/her body composition during training and competition. It is particularly applicable to athletes who compete in sports that use weight class divisions, e.g. boxing, powerlifting, and wrestling.

With regard to nutrition, greater amounts of protein may be needed for competitive weight lifters to maintain a positive nitrogen balance, especially if they are using anabolic steroids (3). However, in light of the high dietary intakes of protein for the subjects in our study, further supplementation of the diet with protein powders and/or amino acids does not seem to be warranted, particularly for female bodybuilders.

Due to the low energy intakes at competition, the dietary intake of calcium was low for both male and female bodybuilders. At competition, bodybuilders restrict the intake of high-fat foods, including dairy products. Calcium intake could be increased by consuming low-fat dairy products during this stage. The dietary intake of zinc and iron were also below the recommended levels of the female bodybuilders. When energy intakes are low, it is difficult to meet the recommended amounts of these nutrients. Although zinc and iron intake can be increased by consuming high protein foods, increasing the protein intake is not recommended because the average dietary intake of protein for the female bodybuilders was already high. Therefore, alternative ways to increase the intake of these minerals are needed. In addition, monitoring the zinc, iron and calcium status of the bodybuilders may help to counteract the risk of developing deficiencies of these nutrients. Further investigation is warranted to formulate more specific recommendations for dietary intake and/or supplementation for bodybuilders as well as other athletes who are restricting dietary intake for weight loss.

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