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Effect of a precompetition bodybuilding diet and training regimen on body composition and blood chemistry

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Objective. **The purpose of this investigation was to document the effect of a 10-wk precompetition bodybuilding diet and training, on blood chemistry and body composition.**
Participant. **One adult male, steroid and drug free, preparing for a first competition.**
Measures. **Average daily dietary intake consisted of 2263 calories (71% protein, 16% carbohydrate, 13% fats), with a protein intake of 5.0 gm·kg^{-1} body mass (BM). Initial body weight of 76.3 kgf (16% body fat) decreased to 63.4 kgf (4.4% body fat). Blood samples for electrolytes, TP, Alb, bilirubin, LDL-C, TG, UA, and amylase were normal. HDL-C levels increased from 65 to 89 mg·dL^{-1}.**
Results. **Decreased glucose levels (<50 mg·dL^{-1}), indicated hypoglycemia. Increased Mg, LD, and CK levels indicated intense training. Increased inorganic phosphorus from 3.7 to 8.2 mg·dL^{-1} suggested lactic acidosis. Increased BUN levels from 16 to 53 mg·dL^{-1} and creatinine from 1.1 to 1.8 mg·dL^{-1} may be attributed to a high protein diet. However, heart muscle enzyme (CK-MB) was not elevated.**
Conclusions. **Substantial changes in body composition and blood chemistry suggest adequate nutrition be ensured, and caution taken to avoid excessive physiologic stresses on the body during precompetition diet and training.**

KEY WORDS: Diet - Blood metabolism - Body composition - Bodybuilding.

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In preparation for a contest, bodybuilders undertake a dietary regimen which is restrictive in calories but high in protein to promote fat loss, and to maintain lean body mass, respectively. This type of dietary regimen, in conjunction with an intense resistance training program, results in dramatic changes in body composition. This has created a research interest in the scientific community regarding the diets, training, and health status of competitive bodybuilders.

Investigations [1-6] generally involved top-level competitors with a great deal of experience in precompetition diets, training, and competitions. However, the reports of these investigations are not necessarily reflective of the practices of novices preparing for a first competition, nor have these investigations examined the stresses imposed upon the body during precompetition dieting and training.

As the sport of bodybuilding increases in popularity, more novices are entering their first competition, and in preparation for it, are using specialized diets advertised in bodybuilding magazines. While preparing for an initial competition without experience in precompetition diets and training, it is unknown as to: (1) the internal stresses imposed on the body of a novice engaging in such specialized diets; (2) the physiological stresses associated with precompetition training; and (3) how the body responds to these stresses. There

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have been anecdotal evidence of novices passing out while preparing for their initial competition. Therefore, the purpose of this investigation was to document the blood chemistry and body composition changes of a novice, preparing for an initial competition, while using a specialized precompetition bodybuilding diet.

Case report

Subject background and training regimen

The subject was a 34 -year (yr) old drug and steroid-free male of Asian descent, who had been bodybuilding regularly and consistently for over 15 yrs, but had never prepared for, or competed in a contest. His bodybuilding regimen during this 15 yr period, consisted of a whole body workout with heavy resistance and low repetitions, 3-4 hours per day (hrs·d^{-1}), 3 days per week (d·wk^{-1}). The subject decided to enter an initial competition for several reasons: (1) the competition was promoted to be natural and steroid free; (2) it was promoted to be a competition for novices; (3) the subject had the time and opportunity to properly prepare for a competition; and (4) the subject wanted to experience a competition before getting too old. To prepare for this initial competition, the subject decided to train with a periodization bodybuilding program while undertaking a specialized precompetition diet that was advertised in a popular bodybuilding magazine.

A 10 week (wk) precompetition training program was used by the subject. This consisted of daily training sessions 4-5 hours (hrs) in duration 6-d·wk^{-1} using a split routine program (upper body training on Monday, Wednesday, Friday; lower body training Tuesday, Thursday, Saturday; and abdominal exercises every day). The first 4-wk consisted of a hypertrophy program (heavy resistance, low repetitions), followed by a 1-wk transition phase to a 4-wk endurance and definition program (low resistance, high repetitions), followed by a 1-wk taper. The training volume was not monitored nor recorded. Postcompetition activity consisted of 1-wk of rest (complete inactivity), followed by 4 -wk of very light resistance training (1-hr in duration, 3-d·wk^{-1}). No cardiovascular training was incorporated in pre or post-training activities.

Body composition

Ten weeks prior to competition, information of the procedures involved in this investigation was provided to the subject, and informed consent obtained. Before initiation of this investigation, body weight (BW), and percent body fat (%FAT) using skinfold measurements, were determined (wk-0). Photographs of the subject standing behind a somatogrid from a front, side, and back profiles were taken, and again 2 days (d) prior to competition (on a weekend at the end of wk 10). Percent fat was calculated from the sum of four skinfold sites (abdomen, suprailium, triceps, and thigh) measured with Harpenden calipers [7] and also determined by UWW techniques.[8] Body weight was obtained using a Toledo Land Scale prior to underwater weighing (UWW). Body density was estimated using the equations of Jackson, Pollack, and Ward,[9] and the Siri [10] equation was used to convert body density to relative body fat. Expired gases collected in rebreathing bags from UWW were analyzed with a Servomex Oxygen Analyzer 570A and a Cavitron Anarad Gas Analyzer model PM-20R. Body weight was recorded on a daily basis by the subject, whereas % FAT by UWW was determined for the subject 2-d before competition (wk 10); 1-d after competition, and weekly for 4 successive weeks post-competition (wk 11-14).

Dietary information

The subject selected a precompetition diet, advertised from a popular bodybuilding magazine, to promote fat loss while maintaining lean body mass, in preparation for competition. The diet consisted of a caloric intake which allowed a range from 1500 to 2500 calories. Fat intake was to be minimized and carbohydrate intake was to be less than 100 grams (g) per day. The majority of the calories consumed were to be from protein sources. Daily food intake was recorded by the subject for the 10-wk precompetition period up to the day of competition. Caloric and nutritional intake was determined from a diet diary (a daily record of food intake by the subject). Instruction was provided on how to record food, and to weigh all foods raw before cooking. The diet selected by the subject was repetitive and monotonous with the same types of food consumed daily throughout the entire precompetition period. To ensure adequate nutrition, the subject consumed a dietary supplement (Diet Fuel, provided by Twin Laboratories Inc.) throughout the pre-competition period. Two servings of Diet Fuel was consumed daily by the subject. The nutritional information provided (by Twin Laboratories Inc.) for 2 servings (77.6 g, 200 kcal, 40 g protein, 10 g CHO, <1 g fat) of Diet Fuel, included: 100% of the RDA for vitamins (A, C, D, E, B-6, B-12), folic acid, thiamine, riboflavin, niacin, calcium, iron, phosphorus, iodine, magnesium, zinc, copper, and pantothenic acid. Because the actual nutrient content was not available, the actual % RDA for each nutrient was not determined. Other information provided for 2 servings of Diet Fuel, included: 20 mg PABA, 400 mg choline, 200 mg inositol, 4 mg manganese, 100 µg selenium, 200 µg chromium, 200 µg molybdenum, 3 mg boron, 1500 mg potassium, 200 mg L-carnitine. Caloric intake from this supplement was included in the food record and nutritional analysis. At the end of each week (7-day record), the food records were turned in, and averaged to approximate a typical day's intake for that week. Total energy intake and levels of nutrient consumption were determined from food label information and from the USDA Handbook Nos. 8-1 through 8-12, 456. During postcompetition the diet was not controlled, and accurate food records

of caloric intake could not be ascertained for caloric and nutritional analysis.

Blood sampling

Blood samples were obtained each week for 4 weeks prior to the competition (wk 7-10) and for 5 wks post competition (wk 11-15). Twelve-hour fasting blood specimens were collected in 13×100 mm B-D Vacutainer SST tubes (Becton-Dickinson and Company, Rutherford, New Jersey). Ten millimeters of the blood specimens were centrifuged within 30 min, serum separated from cells, and serum samples immediately frozen in clean test tubes at -20 C. All samples were collectively assayed at the end of 9 wks (wk 15). A chemistry panel consisting of 23 test procedures was performed using the Beckman Sychron CX7 Clinical System (Beckman Instruments, San Ramon, CA). The high density lipid cholesterol (HDL-C) was first manually prepared using the HDL-C precipitating reagent (Cantrol, Canyon Diagnostics, Inc., Anaheim, CA). The cholesterol content of the HDL-C was then analyzed by the Beckman Sychron CX7 Clinical System. The creatine kinase (CK-MB) was quantified using the CK isoenzyme electrophoresis system (Helena Laboratories, Beaumont, Texas).

Anthropometric changes

Table I lists the body composition changes. At the initiation of the study (wk 0), BW was 76.3 kgf. There was a major reduction in BW to 63.4 kgf two days prior to competition (wk 10), and then an increase to 73.9 kgf one week after competition (wk 11). Percent fat changed markedly from an initial 16.0% prediet/training value to a minimum of 4.4% during the week of competition and to a maximum of 10.4% postcompetition. The subject dropped below two competition weight categories (Middleweight and Lightweight) to compete in the men's Ultra-light (Bantam weight) division (under 67 kgf weight category). He won first place in this weight division and came in second place in the overall competition.

With a postcompetition diet during the first 3 ds after the bodybuilding contest, the subject reported a BW gain of 9.1 kgf (2.7, 3.2, and 3.2 kgf for the 1st, 2nd, and 3rd postcompetition day, respectively). For the first week post-competition (wk 11), the subject described a constant pressure within the thoracic cavity, a bloated feeling in the chest, and edema of the ankles. This phenomenon persisted until initiation of light resistance training in the 2nd postcompetition week.

Dietary intake

The 10-wk precompetition caloric intake; amount of protein and carbohydrates (CHO) consumed; and proportion of calories from protein, CHO, and fats are presented in Figure 1. The daily caloric intake per week, ranged from 1455 calories per day (kcal·d^{-1}) for wk 1, to 2725 kcal·d^{-1} for wk 7-8 with a mean and standard deviation of 2263 kcal·d^{-1} and 419.9 kcal·d^{-1}, respectively. Mean daily protein intake for each week varied and increased from 209 g in wk 1 to 420 g in wk 8-9; whereas CHO intake remained fairly consistent (< 100 g·d^{-1}) throughout the 10-wk period. On the week of competition (wk 10), daily intake was tapered to 1940 kcal, with 349 g of protein and 40 g of CHO. Differences in caloric intake over the first 9-wk was attributed solely to differences in protein consumption (Fig. 1A). This was observed as a change in the protein: CHO ratio (from 2.36 g in wk 1 to 4.93 g in wk 9); and as a change in percentage (from 66% to 72%) of the total calories contributed by protein. The proportion of total calories from protein, CHO, and fats over the 10-wk period was 71%, 16%, and 13%, respectively. The average amount of protein consumed daily over the 10-wk period was approximately 5 g·kg-1 of BW.

TABLE I.—*Body composition.*

Parameters	Precompetition			Postcompetition		
	wk 0	wk 10*	wk11	wk 12	wk 13	wk 14
Body weight (kgf)	76.3	63.4	73.9	72.5	70.8	71.6
Lean body mass (kg)		60.5	70.9	66.6	61.8	64.9
Fat Weight (kgf)		2.9	3.0	5.9	8.9	6.7
Percent fat from						
— Sum of skinfolds	16.0	4.2	8.1	7.8	8.1	9.4
— Underwater weighing	—	4.6	4.1	8.2	12.6	9.4
— Mean+		4.4	6.1	8.0	10.4	9.4

*) Competition occurred on the last day of week; + Calculated from sum of skinfolds and underwater weighing.

Blood chemistry

The means and standard deviations of blood chemistry data are shown in Table II for the pre- (wk 7-10) and postcompetition period (wk 11-15). Substantial biochemical changes were apparent between pre- and postcompetition as a result of the diet and pre-competition training regimen. Most notable was changes in serum glucose (GLU), urea nitrogen (BUN), creatinine (CRE), and intracellular enzymes. Mean precompetition blood values outside the reference range were found for GLU, BUN, serum inorganic phosphorus (PHOS), lactate dehydrogenase (LD), and CK. Serum glucose was found to decrease to levels below normal while dieting and training for competition; whereas total cholesterol (TCHOL), BUN, PHOS, LD, and CK values were observed to increase to levels above normal during this period. Except CK, which is attributed to rigorous muscular activities, all blood values returned to-normal ranges' postcompetition. No detectable CK-MB fraction was noted in all nine serum samples.

Weekly pre- and post-competition values for selected blood chemistry data are shown in Figure 2. Obvious trends and differences can be observed between pre- and postcom-

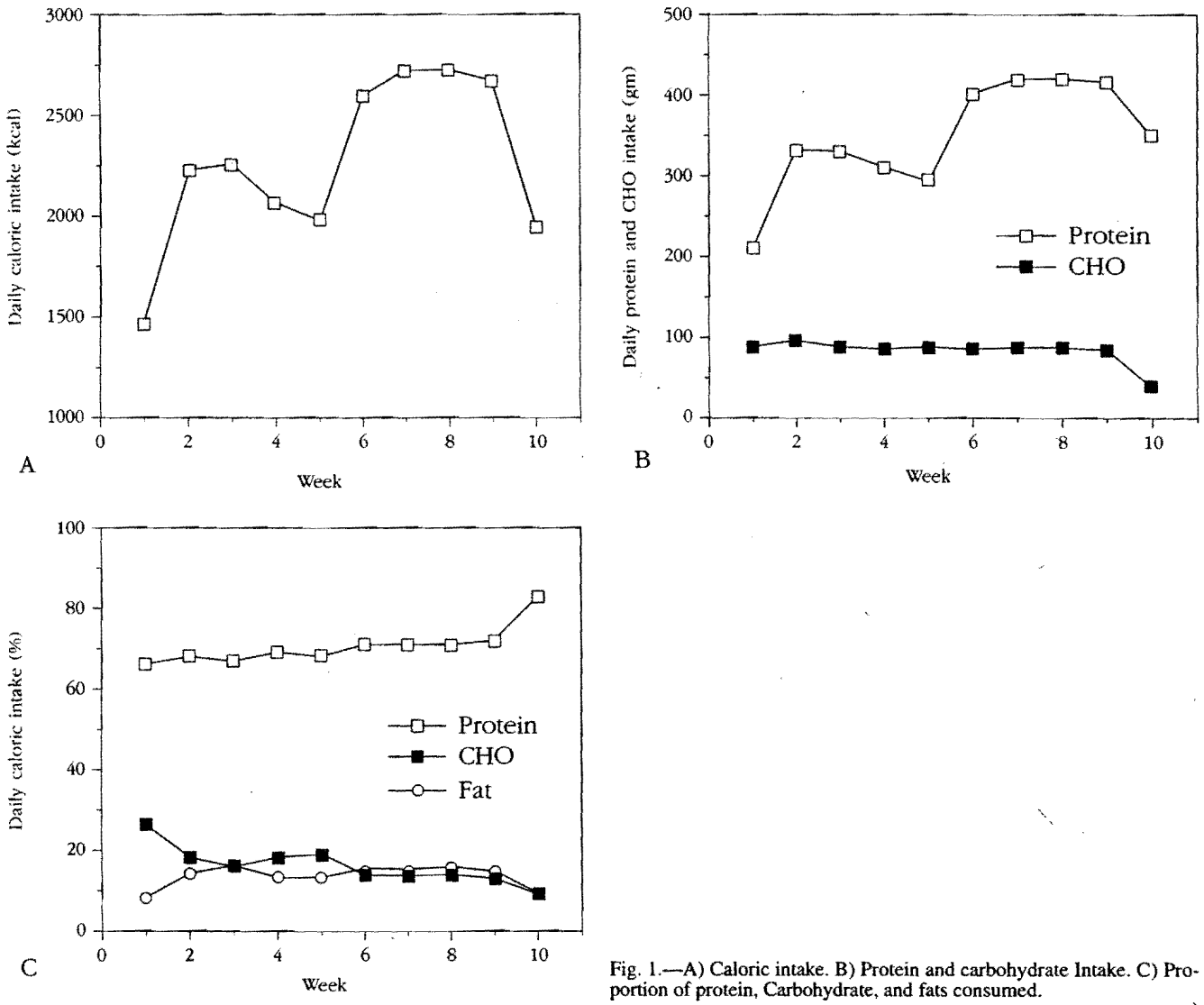

Fig. 1.—A) Caloric intake. B) Protein and carbohydrate Intake. C) Proportion of protein, Carbohydrate, and fats consumed.

petition values. Possibly due to a high protein, low CHO, and low fat precompetition diet, GLU decreased from 79 to less than 50 mg·dL^{-1}, while BUN increased from 16 to 53 mg·dL^{-1}. Triglycerides levels (TG), total cholesterol HDL-C ratio (TCHOL·HDL-C^{-1}), (Table II), and calculated light density lipoprotein cholesterol (LDL-C) increased postcompetition (although within reference ranges). During precompetition training, serum calcium remained within the reference range while there were increments in: PHOS from 3.7 to 8.2 mg·dL^{-1}; CRE from 1.1 to 1.8 mg·dL^{-1}; and high density lipoprotein-cholesterol (HDL-C) from 65 to 89 mg·dL^{-1}. Laboratory results for electrolytes (Na, K, Ca, CO_2), total protein, albumin, bilirubin, uric acid, and amylase were found to be within normal ranges for all pre- and postcompetition samples collected.

Discussion

Pre-contest diet strategy

The diet used in precompetition appears to be markedly different in the proportion of total calories contributed by protein (71%) and CHO (16%) sources, when compared to the precompetition diets of com-

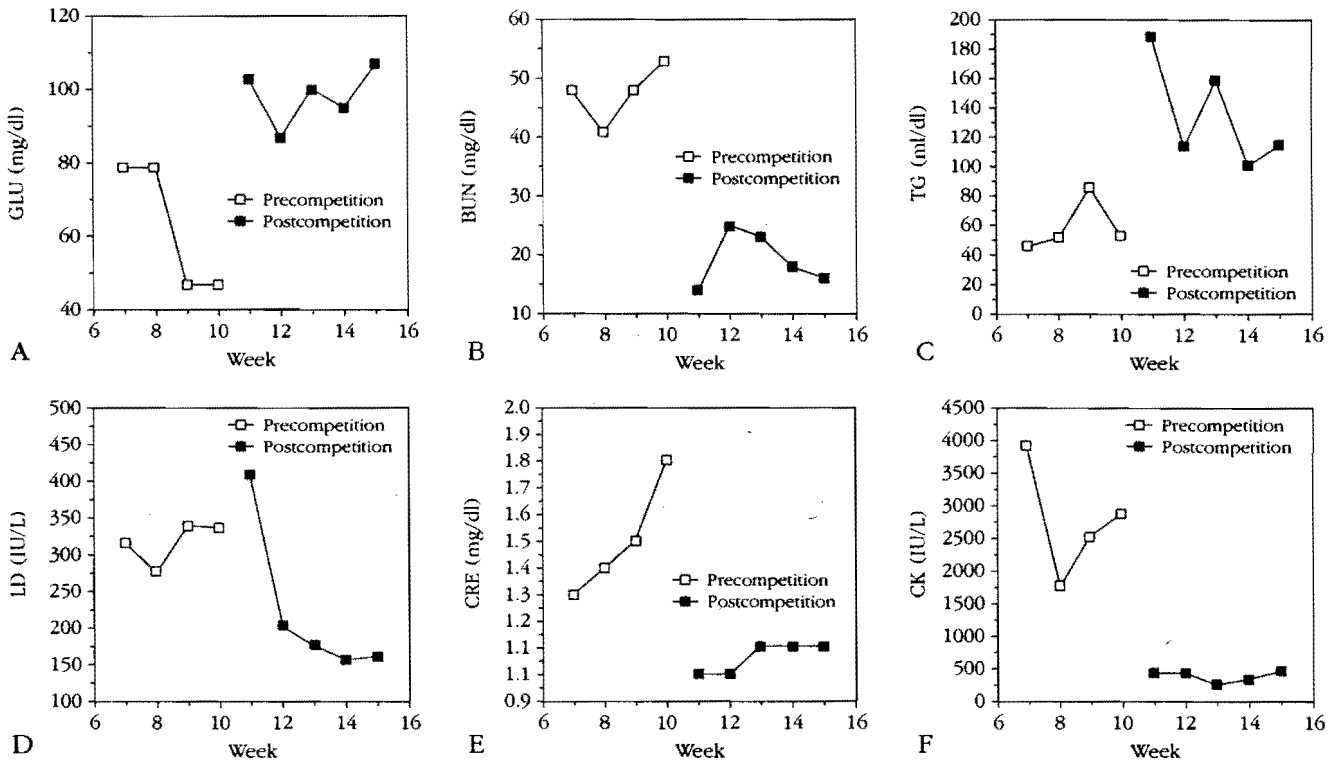

Fig. 2.—Pre- and postcompetition blood chemistry values: A) Blood serum glucose levels. B) Blood urea nitrogen levels. C) Blood triglycerides levels. D) Blood lactate dehydrogenase levels. E) Blood creatinine levels. F) Blood creatine kinase levels.

TABLE II.—*Blood chemistry changes from precompetition to postcompetition.*

Parameters	Precompetition 4 wk (wk 7-10)		Postcompetition 5 wk (wk 11-15)		Reference range for adults	
	Mean (SD) $mg \cdot dL^{-1}$	Mean (SD) mmol/L	Mean (SD) $mg \cdot dL^{-1}$	Mean (SD) mmol/L	$mg \cdot dL^{-1}$	mmol/L
GLU	64 (16)*	3.6 (0.9)	98 (8)	5.4 (0.4)	65-105	3.6-5.8
BUN	47 (4.9)+	16.8 (1.7)	19 (4.7)	6.8 (1.7)	5-26	1.8-9.3
CRE	1.5 (0.2)	133 (17.7)#	1.1 (0.1)	97.2 (8.8)#	0.5-1.5	44-133#
PHOS	5.1 (2.1)+	1.6 (0.7)	3.8 (0.7)	1.2 (0.2)	2.5-4.5	0.8-1.4
TG	59 (18)	0.7 (0.2)	135 (37)	1.5 (0.4)	49-284	0.55-3.2
HDL-C	77 (8)	2.0 (0.2)	70 (14)	1.8 (0.4)	>55	>1.4
TCHOL	253 (24)	6.55 (0.6)	274 (46)+	7.1 (1.2)	138-254	3.57-6.58
TCHOL/HDL-C	3.29 (0.3)		3.91 (0.5)		<3.4	
LD	317 (29)+IU/L		221 (106) IU/L		4-250 IU/L	
CK	2777 (886)+IU/L		393 (89)+ IU/L		10-198 IU/L	

* Low; + High; # umol/L.

petitive bodybuilders (26%-39% protein, 49%-63% CHO) reported in the literature.[2-4 11-13] Although bodybuilders are reported to consume a high protein precompetition diet, the diet selected in this investigation appears to substantially exceed, even the protein intake of elite competitive bodybuilders. However, the daily average fat intake (13% of total calories) during the pre-competition period was comparable to the

values (11%-16%) of competitive bodybuilders reported in the literature.[3 4 11-13]

During this 10-wk precompetition period, the subject experienced vertigo during a training session in wk 1. This coincided with a 3.6 kgf decrement in BW over a 4-d period. When caloric intake was increased (from 1455 kcal·d^{-1} in wk 1 to 2315 kcal·d^{-1} in wk 2), no further incident of vertigo was reported. However, the subject reported constant whole body fatigue and aches; lack of energy; and described sensations of "moving in slow motion", "in a fog" or "in a cloud-like state", during normal daily activities throughout the precompetition diet and training period. In addition, reports by the subject of noticeable and continuous daily decrement in BW, coincided with caloric intake below 2000 kcal·d^{-1} (observed in Figure 1 for wk 1, 5, and 10 of the pre-competition period).

With an average CHO intake of less than 100 g·day^{-1}, and continued bodybuilding training for the entire 10-wk precompetition period, it can be assumed that the subject was CHO and glycogen depleted. This would be an explanation for the dramatic 9.1 kgf increase in weight (from CHO reloading) 3 days postcompetition and the report by the subject; of a bloated feeling in the chest, edema in the ankles, persisting until initiation of light resistance training in the second post-competition week (wk 12). Initiation of some resistance training can be assumed to metabolized excess muscle glycogen stores during the reloading process, and an explanation for the 4.3 kgf decrease in lean body weight from the first postcompetition week (wk 11) to the second (wk 12).

The average daily protein intake (71% of total calories), during the 10-wk precompetition period, averaged 5 g·kg^{-1} BW by the subject in this investigation. This value was greater than values (1.9 - 3.0 g·kg^{-1} BW) reported in the literature for competitive bodybuilders.[3 5 12 13] Walberg-Rankin [14] indicate it is prudent for bodybuilders to consume at least 1.2 g·kg^{-1} ·d^{-1} but not more than 2 g·kg^{-1} ·d^{-1} protein because evidence [10] would suggest that very high protein intake can result in increases in urinary calcium loss. Although normal blood calcium levels were found for our subject, this particular precompetition diet may be contraindicated if protein is predominantly ingested as an isolated nutrient not in the form of food, and if there is a deficiency in phosphorus intake.[15]

The average caloric intake of our subject was 2263 kcal·d^{-1} during precompetition, which was less than the RDA (2300-3100 kcal) for men, but comparable to those reported (2015-2620 kcal) for male bodybuilders in the literature.[4 11 13] It should be noted that reports by the subject of daily decrement in BW, coincided with caloric intake below 2000 kcal·d^{-1}. This would suggest the existence of a caloric threshold during a precompetition diet, below which a noticeable daily decrements in BW (which can be assumed to due-to a loss of lean body mass) would occur. The vertigo experienced by the subject, during a workout in the first week of the precompetition diet, occurred when the average caloric intake was 1455 kcal·d^{-1} (which is comparable to the caloric intake of competitive female bodybuilders).[3 11 13] The vertigo experienced by the subject is believed to be attributed to a hypoglycemic state (due to, both, a decreased total number of calories consumed and a low CHO intake), in conjunction with an intense workout. The subject took corrective measures to rectify this condition, as observed by a substantial (approximately 1000 kcal) increase in caloric intake from wk 1 to wk 2 (Fig. 1). It is possible that our subject (a novice without precompetition experience) could have experienced further dizziness and might have passed out if the average caloric intake remained at 1455 kcal·d^{-1} for an extended period. Although the CHO and total caloric intake during the precompetition period was less than the RDA for men, it is believed that the subject was adequately nourished due to the dietary supplement (Diet Fuel) provided (in conjunction with food consumed).

Anthropometry

Body composition changes during precompetition indicate that BW and % FAT were substantially lower 2 ds prior to competition (wk 10, 63.4 kg, 4.4% FAT) compared to initial precompetition values (wk 0, 76.3 kg, 16% FAT {from skinfold measurements only}) or 4-wk post-competition (wk 14, 71.6 kg, 9.4% FAT). This 4.4% FAT was lower than the 4.9%-6.9% FAT of competitive body builders reported in the literature.[1-5 11 13 16-21] Only Newton *et al.* [12] reported competitive male bodybuilders to have lower % FAT (4.1%). For healthy young men, the lower limit of essential fat is 4-6%.[22 23] Friedl *et al.* [23] reported that a rapid weight loss of approximately 16% BW in young men initially having approximately 15% FAT, will virtually deplete all fat stores except for essential ones. Decreasing BW by more than 16% or attempting to decrease fat stores below 4-6% will result in a loss of

lean tissue.[22] The 12.9 kgf decrease in BW from 76.3 kgf to 63.4 kgf corresponds to a 16.9% decrease in BW, and the change in % FAT (from 16% to 4.4%) would suggest: (1) minimal or no excess fat for the subject at the time of competition; (2) some loss in lean body mass during the precompetition period; and (3) a very effective precompetition diet and training program. Emley *et al.* [24] reported lean tissues of bodybuilders to decrease 2.16 kg precompetition and increase 6.64 kg postcompetition.

Biochemical measures

Observations of the blood chemistry results would suggest that significant biochemical changes had occurred between pre- and postcompetition blood values. Increased levels of LD, CK, and creatinine are consistent with excessive trauma to skeletal muscles during (what can now be concluded to be) very vigorous precompetition bodybuilding training. Continuous high volume training throughout the precompetition period would suggest that there was no myocardial infarction and that all CK fractions were skeletal muscle origin. This was confirmed by the CK isoenzyme electrophoresis results, showing markedly elevated MM fraction only with no CK-MB fraction. Cade *et al.* [25] showed that CK and LD of swimmers increased as a result of high-intensity training. The fluid and dietary manipulation could affect the extent of muscle damage, using a glucose-electrolyte and a milk-protein supplement. A milk-protein supplement given during the recovery period caused a rapid decreased in intracellular enzymes while a glucose-electrolyte given during exercise protected muscle damage, as first reported by Millward *et al.* [26]

The observation that the rapid return of both CK and LD to normal values within 1-wk postcompetition after a high-protein diet, was similar to findings reported in the literature.[25 26] An experience of vertigo, lack of energy, sensation of "moving in slow motion" or "in a fog" or "in cloud-like state" during the precompetition period is consistent with a state of hypoglycemia (blood glucose level decrement to 50 $mg \cdot dL^{-1}$). This is lower than the reported blood glucose levels (84 $mg \cdot dL^{-1}$) of 11 male championship bodybuilders 24 hrs before competition.[4] During a study to determine biochemical changes among obese volunteers consuming 0.5-1.0 g $protein \cdot kg^{-1}$ BM,[27] the only decrement was in blood sugars and insulin levels. There was no change in creatinine clearance, BSP retention, serum bilirubin and urinary steroid levels. The data of this investigation were very similar, indicating no liver or kidney damage during the intense bodybuilding precompetition training period.

Stunkard and Rush [28] found that low caloric intake adversely affected psychological state such as mood disturbance during severe training stress. Moreover, Newton *et al.* [12] reported that subjects experienced more fatigue, depression, tenseness, confusion and significantly less vigor during the weeks before the body building competition. The body aches may be attributed to a state of muscular lactic acidosis which also increases serum inorganic phosphorus level.[29] A high protein diet during precompetition markedly increased the blood urea nitrogen without greatly increasing the serum creatinine level. A possibility of dehydration was ruled out due to normal serum total protein and albumin results. Although hematocrit (HCT) was not measured in this experiment, hemoconcentration could also be ruled out due to normal total protein and albumin results. However, HCT may be elevated in extreme physical exercise.

Although serum cholesterol level remained relatively constant, serum HDL-C was elevated (highest value was 89 $mg \cdot dL^{-1}$) during the precompetition training period. The subject average HDL-C level (77 $mg \cdot dL^{-1}$ over wk 7-10) during this period was substantially higher than the 37-48 $mg \cdot dL^{-1}$ reported in the literature [1 16 17] for male competitive bodybuilders not using steroids. Only the elite world class bodybuilder examined by Manore [5] had comparable HDL-C levels (65 $mg \cdot dL^{-1}$). The subject, with normal baseline HDL-C levels of 60-65 $mg \cdot dL^{-1}$ confirms the observation that exercise will increase the HDL-C production.[30 31] It is clearly apparent that a high protein diet in conjunction with an intense body building regimen will result in significant leakage of intracellular enzymes, creatinine, and inorganic phosphorus and induce a state of hypoglycemia. The high protein diet also increased blood urea nitrogen level due to increased production of ammonia. Serum urate levels remained relatively unchanged; 6.5 ± 0.6 $mg \cdot dL^{-1}$ and 7.5 ± 2.0 $mg \cdot dL^{-1}$ in pre and postcompetition, respectively; and were within the reference range.

Conclusions

In summary, the precompetition diet and training selected by the subject for his first contest was appar-

ently successful, as evidenced by the subject's first place standing in his weight division and second place finish overall. However, the diet selected from a popular bodybuilding magazine by the subject was substantially much higher in protein and lower in CHO than the precompetition diet of experienced high level competitive bodybuilders. This diet (and accompanying training) resulted in a lower body fat percentage (with minimal or no excess fat stores at the time of competition), and substantial changes in blood chemistry. In addition, vertigo, constant whole body fatigue, aches, and lack of energy was reported by the subject during the precompetition period. This would suggest that measures be taken to ensure adequate nutrition and caution advised for novices preparing for their first competition, to avoid excessive physiologic stresses on the body.

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References

1. Bazzarre TL, Kleiner SM, Litchford MD. Nutrient intake, body fat, and lipid profiles of competitive male and female bodybuilders. J Am Coll Nutr 1990;9:136-42.
2. Hickson JF, Johnson TE, Lee W, Sidor RJ. Nutrition and the precontest preparations of a male bodybuilder. J Am Diet Ass 1990;20:264-267.
3. Kleiner SM, Bazzarre TL, Ainsworth BE. Nutritional status of nationally ranked elite bodybuilders. Int J Spt Nutr 1994;4:54-69.
4. Kleiner SM, Bazzarre TL, Litchford MD. Metabolic profiles, diet, and health practices of championship male and female bodybuilders. J Am Diet Ass 1990;90:962-7.
5. Manore MM, Thompson J, Russo M. Diet and exercise strategies of a world-class bodybuilder. Int J Sport Nutr 1993;3:76-86.
6. Walberg-Rankin J, Edmonds CE, Gwazdauskas FC. Diet and weight changes of female bodybuilders before and after competition. Int J Sport Nutr 1993;3:87-102.
7. Lohman T, Roche AF, Martorell RM. Anthropometric standardization reference manual. Champaign: Human Kinetics Publishers, 1991.
8. Wilmore JH. A simplified method for determination of residual lung volumes. J Appl Physiol 1969;27:96-100.
9. Jackson A, Pollack A, Ward A. Generalized equations for predicting body density of women. Med Sci Sports Exerc 1980;12:175-82.
10. Siri WE. Gross composition of the body. In: Lawrence JH, Bobias CA, editors. Advances in Biological and MedicalPhysics. New York: Academic Press, 1956;4:239-80.
11. Heyward VH, Sandoval VM, Colville BC. Anthropometric, body composition, and nutritional profiles of bodybuilders during training. J Appl Sports Sci Res 1989;3:22-9.
12. Newton E, Hunter G, Bammon M, Roney R. Changes in psychological state and self-reported diet during various phases of training in competitive bodybuilders. J Strength Cond Res 1993;7:153-8.
13. Sandoval WM, Heyward VH, Lyons TM. Comparison of body composition, exercise and nutritional profiles of female and male body builders at competition. J Sport Med 1989;29:63-70.
14. Walberg-Rankin J. A review of nutritional practices and needs of bodybuilders. J Strength Cond Res 1995;9:116-24.
15. Heaney RP. Protein intake and the calcium economy. J Am Diet Ass 1993; 93:1259-60.
16. Bazzarre TL, Kleiner SM, Ainsworth BE. Vitamin C intake and lipid profiles of competitive male and female bodybuilders. Int J Sport Nutr 1992;2:261-71.
17. Elliot DL, Goldberg L, Kuehl KS, Catline DH. Characteristics of anabolic-androgenic steroid-free competitive male and female bodybuilders. Physician Sportsmed 1987;15:169-79.
18. Fahey TD, Akka L, Rolph R. Body composition and VO_2 max of exceptional weight-trained athletes. J Appl Physiol 1975;39:559-61.
19. Katch VL, Katch FI, Moffatt R, Grittleson M. Muscular development and lean body weight in body builders and weight lifters. Med Sci Sports Exerc 1980;12:340-4.
20. Pipes TV. Physiologic characteristics of elite body builders. Phys Sportsmed 1979;7:116-22.
21. Spitler DL, Diaz FJ, Horvath SM, Wright JE. Body composition and maximal aerobic capacity of bodybuilders. J Sport Med 1980;20:181-8.
22. Fleck SJ. Lower limit of body fat in males. NSCA J 1995;17:26.
23. Friedl KE, Moore RJ, Martinez-Lopez LE, Vogel JA, Askew EW, Marchitelli LJ *et al.* Lower limit of body fat in healthy active men. J Appl Physiol 1994;17:933-40.
24. Emley C, Kwiatkowski K, Perry A, Signorile J, Allison M. Physiological and dietary changes in bodybuilders preparing for competition. Med Sci Sports Exerc 1994;26:S39.
25. Cade JR, Reese RH, Privette RM, Hommen NM, Rogers JL, Fregly MJ. Dietary intervention and training in swimmers. Eur J Appl Physiol 1991;63:210-5.
26. Millward DJ, Davis CMT, Halliday D, Wolman SL, Matthews D, Rennie M. Effect of exercise on protein metabolism in humans as explored with stable isotopes. Fed Proc 1982;41:2686-91.
27. Blackburn L, Bistrian R, Flatt JP. Role of a protein sparing fast in a comprehensive weight reduction programme. In: Howard A, editor. Recent Advances in Obesity Research. Proceedings of the 1st International Congress on Obesity. London: Newman Publishing Ltd., 1975:279-81.
28. Stunkard AJ, Rush J. Dieting and depression reexamined. Ann Intern Med 1974;81:526-33.
29. Tietz, N. Clinical Guide to Laboratory Tests. W.B. Saunders Company, 1995:487.
30. Johnson CC, Stone MH, Byrd RJ, Lopez-s A. The response of serum lipids and plasma androgens to weight training exercise in sedentary males. J Sport Med 1983;23:39-44.
31. Webb LO, Laskarzewski PM, Glueck CJ. Severe depression of high-density lipoprotein cholesterol levels in weight lifters and body builders by self-administered exogenous testosterone and anabolic-androgenic steroids. Metabolism 1984;33:971-5.