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Nutritional Status and Lipid Profiles of Trained Steroid-Using Bodybuilders

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Fourteen trained male anabolic steroid-using bodybuilders (SBBs) (19–41 years) were recruited for the study. Three-day diet records were obtained from SBBs and analyzed. A resting venous blood sample was drawn, and serum/plasma was subsequently analyzed for various nutritionally related factors. Results showed that mean dietary energy (4,469 ± 1,406 kcal), protein (252 ± 109 g), and vitamin and mineral intakes of SBBs greatly exceeded U.S. Recommended Dietary Allowances. Dietary cholesterol intake was 2.8 times the recommended levels. Mean serum/plasma nutrient concentrations of SBBs were within normal range. However, individual SBBs had a number of serum/plasma values outside of the normal or recommended range, the most notable of which was hypercalcemia, which was present in 42% of SBBs. Serum/plasma lipids were such as to increase the risk of cardiovascular disease in these subjects.

Key Words: diet, anabolic steroids, blood lipids, nutrient status, vitamins, minerals

Interest in the relationships between nutrition, exercise, and health has increased in recent years. This has been especially true with respect to aerobic exercise (running, cycling, etc.). However, much less data are available on the nutrient status of resistance-trained athletes such as weight lifters, power lifters, and bodybuilders. In addition, resistance-trained athletes are more likely to self-administer anabolic steroids than endurance athletes, further complicating this area of study. Anabolic steroid use has been reported to be relatively extensive among resistance-trained athletes (7, 19, 30). Some investigators have estimated that between 35 and 90% of national and world-class competitors in sports where muscular strength and size are of primary importance have used or are using anabolic steroids (7, 30). Steroids also have been used by high school and other

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athletes at local levels (22, 28) and by nonathletes for cosmetic or recreational purposes (29). Adequate knowledge as to how steroid use affects the nutritional and health status of these individuals is, therefore, important. Such knowledge would allow physicians and health care personnel to give better advice on the consequences of steroid use and abuse.

The scant nutrient status data that have been collected on anabolic steroid–using athletes have been concerned predominantly with blood lipid changes. It has been established that 17-alpha alkylated steroid use significantly reduces HDL-cholesterol levels and possibly increases total cholesterol (4, 5, 11). These changes could increase an athlete's chances of developing cardiovascular disease (29). However, data for dietary intakes and nonlipid plasma/serum nutrient concentrations are sparse.

Therefore, the purpose of the present investigation was to determine the nutritional status and lipid profiles of a group of trained steroid-using bodybuilders (SBBs). These objectives were achieved by evaluating 3-day dietary intakes and plasma/serum nutrient and lipid profiles. The dietary intake values and plasma/serum profiles were compared to normal reference values.

Methods

Fourteen trained male bodybuilders, who were self-administering anabolic steroids, were recruited for the study. All subjects were taking steroids at the time of data collection. All were classified as National Physique Committee Level II or III (state and regional level) competitors, and most subjects had competed within the previous 18 months. All bodybuilders had been training for at least 2 years. None of the bodybuilders were on a strict precompetition diet. Subjects were recruited from health clubs and gyms located in the region.

The protocol for the present project was approved by the Institutional Review Board for Human Subjects, Auburn University. All subjects provided informed consent. All data collection and analyses were performed in a blind manner.

Prior to providing diet information and blood samples, all subjects completed a general questionnaire. Data on height, weight, age, and anabolic steroid use were obtained at this time.

Dietary intakes of subjects were obtained with 3-day food records. Records included 2 weekdays and 1 weekend day. Prior to obtaining food records, subjects met with a registered dietitian, who provided instructions on portion size control, how to record intakes, and the importance of recording complete data. Food models were used to help establish portion size control. Dietary record data were analyzed by computer (Nutritionist III, N-Squared Computing, Salem, OR) for energy, carbohydrate, lipid, protein, vitamin, and mineral content. Dietary data were compared to appropriate Recommended Dietary Allowance (RDA) values (14).

All subjects provided a resting 20-ml blood sample, which was obtained via venipuncture of the antecubital vein. One-half of the blood sample was collected into a tube containing anticoagulant, and the other 10 ml was collected into a tube without anticoagulant. Subjects were 4–6 hr postprandial, and all samples were drawn in the early evening (5–7 p.m.) prior to any workout. Samples were immediately placed on ice in the dark. Blood was centrifuged within 2 hr, and plasma or serum was obtained. Samples were frozen at –70 °C for subsequent nutrient analysis. Serum urea nitrogen was analyzed within 48 hr, and all other analyses were performed within 30 days. Plasma was analyzed using standard spectrophotometric-colorimetric procedures obtained in kit from Sigma Chemical Co. (St. Louis, MO) for the following nutrients: albumin (Kit #631), urea nitrogen (Kit #535), cholesterol (Kit #352), HDL-cholesterol (Kit #325-4), triglycerides (Kit #405), glucose (Kit #315), calcium (Kit #587), phosphorus (Kit #360), and magnesium (Kit #595). Serum iron was analyzed using Kit #565. LDL-cholesterol was subsequently calculated from existing cholesterol, HDL-cholesterol, and triglyceride values. The cholesterol/HDL-cholesterol ratio also was calculated.

Results

Data for age, height, and weight are shown in Table 1. While exact steroid use data were difficult to obtain, questionnaire data did indicate that SBBs were self-administering multiple steroids both orally and through intramuscular injections. Total dosages ranged from 25 to 250 mg of the various steroids per day. SBBs had been taking the drugs on a cyclical basis (6–15 weeks/cycle) for 2–10 years. Drugs that were taken are as follows: Anadrol-50 (oxymetholone), Dianabol (methandrostenolone), Depo-testosterone (testosterone cypionate), Anavar (oxandrolone), Deca-durabolin (nandrolone decanoate), and Winstrol (stanozolol).

Dietary intake data of SBBs can be found in Tables 2, 3, and 4. Mean intake for energy and all nutrients analyzed met or exceeded RDA values. No low mean intake values were noted in the group. Individual values below the

Table 1 Mean Age, Height, and Weight Data of 14 Steroid-Using Male Bodybuilders

Variable	*M*	*SD*
Age (years)	26	6
Height (cm)	177	8
Weight (kg)	93.0	12.5
Body mass index (kg/m^2)	29.8	2.5

Table 2 Daily Macronutrient and Cholesterol Intakes of 14 Steroid-Using Male Bodybuilders From 3-Day Diet Records

	Daily intake				No. subj.	No. subj.
Nutrient	*M*	*SD*	Range	% RDA	< RDA	> RDA
Energy (kcal)	4,469	1,406	2,888-7,570			
Protein (g)	252	109	124-500	350[a]	0	14
Fat (g)	151	93	49-403			
Carbohydrate (g)	544	193	241-756			
Cholesterol (mg)	844	430		281[b]	1	13

[a]Compared to the protein RDA of 0.8 g/kg of body weight (21). [b]Compared to National Cholesterol Education Program guideline of <300 mg/day (20).

Table 3 Daily Vitamin Intakes of 14 Steroid-Using Male Bodybuilders From 3-Day Diet Records

Nutrient	Daily intake M	Daily intake SD	Daily intake Range	% RDA	No. subj. < RDA	No. subj. > RDA
Thiamin (mg)	3.9	1.7	2.0-7.2	173[a]	1	13
Riboflavin (mg)	5.5	2.9	2.4-12.9	204[a]	1	13
Niacin (mg)	72.8	35.6	28.8-142.0	245[a]	0	14
Pyridoxine (mg)	5.0	2.8	0.7-10.1	236	3	11
Folacin (μg)	753	477	174-1,125	376	1	13
Cobalamin (μg)	12.1	7.6	4.1-30.3	603	0	14
Vitamin C (mg)	222	237	45-948	370	3	11
Vitamin A (IU)	15,386	9,167	3,650-37,171	304	2	12
Vitamin D (IU)	508	502	84-2,078	199	5	9
Vitamin E (IU)	15.0	20.3	1.4-84.5	100	7	7

[a]Compared to RDA of 0.5, 0.6, 6.6 mg/1,000 kcal for thiamin, riboflavin, and niacin, respectively (21).

Table 4 Daily Mineral Intakes (in mg) of Steroid-Using Male Bodybuilders From 3-Day Diet Records

Nutrient	Daily intake M	Daily intake SD	Daily intake Range	% RDA	No. subj. < RDA	No. subj. > RDA
Sodium	5,511	2,003	3,304-11,075			
Potassium	6,950	3,533	2,466-12,852			
Calcium	2,277	1,666	1,022-6,707	259	1	13
Phosphorous	3,561	1,890	1,577-8,419	412	0	14
Magnesium	688	376	233-1,364	192	4	10
Iron	36.5	15.8	16.5-74.7	343	0	14
Zinc	24.7	13.0	9.4-48.9	165	3	11

RDA were most common for vitamins D and E and the mineral magnesium. Protein comprised 22% of the kilocalories consumed, carbohydrates 49%, and fat 29%. Subjects consumed 2.7 g of protein and 5.8 g of carbohydrate per kilogram of body weight. Dietary cholesterol intake was approximately 2.8 times greater than recommended (20).

Serum/plasma nutrient and lipid variables are shown in Table 5. All mean values were within normal range (20, 31). Comparisons of individual plasma/serum values with normal range are shown in Table 6. Several subjects were above normal or recommended range for total cholesterol (3 subjects), cholesterol/HDL-cholesterol ratio (6 subjects), calcium (6 subjects), and phosphorus (4 subjects). Five subjects were below recommended range for HDL-cholesterol.

Table 5 Serum or Plasma Nutrient Levels of 14 Steroid-Using Male Bodybuilders

Blood variable	Concentration *M*	*SD*	Range	Normal range[a]
Albumin (g/dl)	4.8	0.4	3.8-5.6	3.2-5.5
Urea nitrogen (mg/dl)	14.0	3.3	9.5-20.6	11.0-23.0
Triglycerides (mg/dl)	98	37	52-163	1-250
Cholesterol (mg/dl)	198	52	131-327	<240
HDL-cholesterol (mg/dl)	43	14	15-68	>35
LDL-cholesterol (mg/dl)	136	53	64-279	<165
Cholesterol/HDL cholesterol ratio	5.7	1.3	2.3-21.8	<4.5
Glucose (mg/dl)	89	8	71-99	70-115
Calcium (mg/dl)	10.3	1.2	8.4-12.0	8.5-10.5
Phosphorus (mg/dl)	4.0	1.1	2.6-6.1	3.0-4.5
Magnesium (mg/dl)	2.0	0.4	1.4-3.0	1.8-3.0
Iron (μg/dl)	87	31	34-151	60-200

[a]Normal and recommended values obtained from (20) and (31).

Table 6 Percentages of Steroid-Using Male Bodybuilders (*N* = 14) With Plasma/Serum Nutrient Values Above or Below Normal Range

Blood variable	% Below range	% Above range
Cholesterol	—	21
HDL-cholesterol	36	—
LDL-cholesterol	—	21
Cholesterol/HDL-cholesterol ratio	—	42
Albumin	—	07
Urea nitrogen	21	—
Calcium	—	42
Phosphorus	—	29
Magnesium	21	—
Iron	21	—

Note. Dashes indicate that no abnormal values existed for that nutrient.

Discussion

Steroid use in the current study was at a level greater than doses typically prescribed for legitimate medical purposes (12, 19). However, doses in the present study were comparable to reported values of other athletes self-administering anabolic steroids (23). The process of "stacking" that was noted among the steroid users, whereby athletes administer different types of steroids at the same time, and the administration of steroids for cycles of 6–15 weeks are consistent with steroid use reported by others (5).

Energy and nutrient intakes of bodybuilders in the present study were similar to values previously reported by Short and Short (25) for bodybuilders but were somewhat greater than the bodybuilder values reported by Heyward et al. (10). None of the bodybuilders in the present study were in the competition diet phase of their training. Thus, energy and nutrient intakes in the present study were higher than those reported by other investigators studying this phase of bodybuilders' diets (1, 13, 14, 24); these investigators studied bodybuilders who were on diets immediately prior to competition.

There were no mean nutrient intake values in the current study that could be considered low. In fact, most mean nutrient intakes were 2–6 times RDA values. However, certain individuals were below RDA values; this was most noteworthy for vitamin E and magnesium. In general, data from the current study would not support the need for ongoing protein, vitamin, or mineral supplementation for these bodybuilders. However, this may not be true for bodybuilders on strict competition diets.

Total dietary cholesterol intake was approximately three times greater than current recommendations (20), probably due to the high consumption of meat in this group. This level of cholesterol intake may contribute to a greater risk of cardiovascular disease in SBBs.

While mean serum lipid values were in the normal range, a number of individual serum lipids in SBBs were not favorable, possibly resulting in an increased risk for cardiovascular disease. This relationship has been previously reported (4, 8, 11, 16) and seems to be a well-established effect of steroid use. Thirty-six percent of SBBs had HDL-cholesterol concentrations below the minimum recommended value. In addition, the mean total cholesterol/HDL-cholesterol ratio was above recommended guidelines, placing the subjects at increased risk for cardiovascular disease. While the use of anabolic steroids has not definitely been shown to cause heart disease, continued use of the drugs over a number of years may contribute to the development of the disease. There are several case reports of steroid-using athletes developing heart disease (30).

All mean serum/plasma nutrient values were within normal range as reported in the literature (31), although mean calcium concentrations were high normal and mean magnesium concentrations were low normal. However, SBBs had a large number of individual plasma/serum values outside of the normal or recommended range. This was particularly true of serum calcium, as 42% of SBBs had hypercalcemia. To our knowledge, this is the first time that this problem has been identified in steroid-using athletes. Our data do not provide clear reasons for this hypercalcemia; it could be a problem due to steroid administration, high levels of calcium intake, or some combination of the two. However, this phenomenon is worthy of further investigation. We could not find any reports on the effects of anabolic steroids on blood calcium, parathyroid hormone or calcitonin secretion, or calcium absorption. However, several studies have reported that anabolic steroid administration does increase bone calcium content (3, 9, 17). In addition, one paper reported increased intracellular calcium concentrations in rat osteoblasts when the cells were exposed to androgens (18).

Mean plasma magnesium concentrations were low normal in the present group of bodybuilders, and 21% had plasma magnesium levels below normal range. Kleiner et al. (14) also reported serum magnesium concentrations to be at the low end of the normal range in a group of championship male and female bodybuilders. Lefavi et al. (15) followed for 90 days the red blood cell (RBC) magnesium concentrations in a world-class bodybuilder taking a magnesium supplement. RBC magnesium did increase over the 90 days but remained below the acceptable RBC magnesium standard after the experimental period. Casoni et al. (2) found significantly lower serum Mg in a group of runners compared with a nonactive control group. However, mean Mg concentrations for both groups were within the normal range. Several other studies, using predominantly aerobic athletes, found normal blood Mg concentrations in their subjects as well as controls (6, 26, 27). Magnesium may be a mineral worthy of further study in bodybuilders.

In summary, overall dietary nutrient intakes in the present group of SBBs were well above recommended levels. Thus, there probably would not be any advantage for these subjects to take nutrient supplements, as is frequently done by bodybuilders. The depressed HDL-cholesterol levels and the elevated total cholesterol/HDL-cholesterol ratio would seem to place SBBs at greater risk for the development of cardiovascular disease. If steroid use continued over a long period of time, this increased risk could represent a significant problem for these steroid-using athletes. Finally, a number of SBBs had plasma/serum values outside of normal ranges. Hypercalcemia was present in 42% of SBBs, which could have adverse outcomes on the long-term health of these individuals.

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