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Case Report

High Resistance Training Volume and Low Caloric and Protein Intake Are Associated with Detrimental Alterations in Body Composition of an Amateur Bodybuilder Using Anabolic Steroids: A Case Report

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Abstract: Many bodybuilders use anabolic androgenic steroids (AAS) to potentiate muscle mass gain as a result of specific resistance training and nutrition. The case we describe hereafter outlines alterations in body composition of an amateur bodybuilder during his pre-competitive period (11 weeks). The Participant was a 28-year old Caucasian male who was aiming to participate in his first bodybuilding competition under the "Men's Physique" category. The Participant self-administered AAS for the whole pre-competitive period, followed a 13 set-meal plan consisting of 10 daily meals interspersed by approximately 2 h, and performed six high-volume resistance-training sessions a week. Body mass and anthropometric variables were measured at the beginning, during and at the end of his pre-competitive period. Dietetic analysis revealed a reduction in protein intake at the 10th (% decrease: −51.3%) and 11th weeks (% decrease: −64.5%) and in calorie intake at the 10th (% decrease: −57.9%) and 11th weeks (% decrease: −59.5%) in comparison to the 1st week. As a result, the Participant reduced both total body mass and fat percentage. However, there was a reduction in absolute fat free mass, despite the use of AAS. Apparently, the combination of excessive volumes of training with inadequate protein consumption was responsible for this outcome.

Keywords: anabolic androgenic steroids; bodybuilding; resistance training; body composition; weight training

1. Introduction

Bodybuilding is a sport aimed at increasing muscle mass and decreasing body fat percentage [1]. These changes in body composition occur due to an association of resistance and aerobic training with a strict nutritional diet [1]. Bodybuilding is usually planned in two phases: a preparatory phase that emphasizes muscle hypertrophy (off-season), followed by another phase that emphasizes muscle definition (pre-competitive) [2]. The preparatory phase usually consists of combining resistance training with a high caloric and protein intake, with the purpose of increasing muscle mass [3]. The pre-competitive phase is mainly characterized by an increased volume of aerobic exercise, caloric restriction and dehydration in order to potentiate muscle definition [4]. Together, these phases are responsible for substantial changes in the bodybuilder's body composition.

In addition to training and diet, bodybuilders also employ other strategies to maximize their desired body composition, including a massive usage of dietary supplements and anabolic-androgenic steroids (AASs) [5–7]. AASs are derivatives of androgenic hormones such as testosterone. Supraphysiological elevations in testosterone concentrations stimulate protein synthesis, and results in an increase in muscle size, body mass and strength [8]. Nonetheless, indiscriminate use of AAS can lead to many well-known side effects, such as detrimental lipid profile changes, elevated blood pressure, decreased myocardial function, gynecomastia, decreased sperm count, testicular atrophy, sexual impotence, increased risk of liver tumors and liver damage, premature epiphyseal plate closure, increased risk of tendon tears, intramuscular abscess, psychological disorders and, specifically in women, menstrual irregularities, clitoromegaly and masculinization (for a review, see Hoffman and Ratamess) [9].

In the present case, we report the practices adopted and the changes in body composition of an amateur bodybuilder during the pre-competitive period, and also make a critical analysis of the current practices adopted based on scientific evidence, offering alternatives for people involved or willing to be involved in bodybuilding.

2. Case Report

2.1. The Participant

The Participant for the case is a 28-year old Caucasian man, night-watchman, 1.77 m who practices amateur bodybuilding, and was preparing to compete in his first event in the Men's Physique category (allowed for bodybuilders up to 1.78 m). He was followed during the 11 weeks of the pre-competitive period. The competition was a regional contest held in Goiânia, in 2016. This competition was devoted to debutant athletes and the Participant placed seventh among 24 participants. The Participant had seven years of experience with resistance training, was a non-smoker, and did not consume alcoholic drinks.

This study was carried out in accordance with the recommendations of the Federal University of Goiás Ethics Committee, in accordance with the Declaration of Helsinki, and with written informed consent from the Participant. The protocol was approved by the Federal University of Goiás Ethics Committee.

2.2. Self-Administration of AAS (Anabolic Androgenic Steroids)

The Participant admitted having self-administered AAS during the entire pre-competitive phase, and the last time he had used AAS was 14 weeks before the beginning of the pre-competitive phase. He used four types of AAS, varying according to the week's workout: drostanolone propionate, trenbolone acetate, testosterone propionate and testosterone enanthate. AAS were administered in the gluteal region alternating each side. Table 1 shows the schedule of self-administration by the Participant.

Table 1. The AAS (anabolic androgenic steroids) self-administered during the 11 weeks.

AAS	1st–4th Week		5th–6th Week		7th–10th Week		11th Week	
	A (mg)	WF	A (mg)	WF	A (mg)	WF	A (mg)	WF
Testosterone Enanthate	300	2	—	—	—	—	—	—
Testosterone Propionate	50	7	70	7	70	7	—	—
Trenbolone Acetate	50	DODO	50	DODO	100	DODO	75	7
Drostanolone Propionate	50	DODO	50	DODO	100	DODO	75	7

A = Amount used; WF = Weekly frequency; DODO = Day on, day off.

Briefly, the Participant took around 1250 mg of AAS from weeks 1 to 4, 790 mg during weeks 5 and 6, 1090 mg from week 7 to week 10, and 1050 mg of during the 11th week. According to him, the AAS administration protocol was "prescribed" by another amateur bodybuilder, and purchased online.

In addition, the Participant ingested 15 mg/day of ephedrine sulphate (Sanofi Aventis, São Paulo, Brazil) and 120 mg of theophylline (Sanofi Aventis) with 200 mL of coffee 15 min before each training session. In the last three weeks, he ingested 35 mg/day of ephedrine sulphate (Sanofi Aventis) and 240 mg of theophylline (Sanofi Aventis) again with 200 mL of coffee 15 min before each training session.

2.3. Nutritional Advice

The Participant followed a 13 set-meal plan designed by a sports nutritionist, comprising ten daily meals interspersed by approximately 2 h. The Participant did not take any dietary supplements. Carbohydrate recommendations focused on low and medium glycemic index (GI) sources to improve satiety [10] and enhance lipolysis [11]. During the last two weeks preceding the championship, carbohydrate intake was abruptly reduced, while the Participant was instructed to consume high biological value protein, such as chicken and eggs, and to distribute protein intake throughout the day in order to improve satiety [10], retain fat-free mass (FFM), and augment fat loss whilst in energy deficit [12]. The analysis of the Participant's diet was performed with help of *DietBox* software (Dietbox, Porto Alegre, Brazil, version 1.0) using the USDA database for nutrient quantification. We requested that the participant record his food intake using the 24-h dietary recall for each week. Dietetic analysis revealed a reduction in protein intake at the 10th (absolute decrease: −113.6 kcal; % decrease: −51.3%) and 11th weeks (absolute decrease: −142.9 g; % decrease: −64.5%), and in calorie intake at the 10th (absolute decrease: −2194 kcal; % decrease: −57.9%) and 11th weeks (absolute decrease: −2252 kcal; % decrease: −59.5%) in comparison to the 1st week (see Table 2).

Table 2. Food intake during the 11 weeks.

Nutrients	Weeks										
	1st	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**	**8th**	**9th**	**10th**	**11th**
Total Calorie (kcal)	3788	2346	2769	2402	2279	2123	2072	1680	2051	1594	1536
Protein (g/kg b.m.)	2.7	3.5	3.9	3.3	3.3	2.9	2.1	3.4	2.9	1.3	1.0
Protein (g)	221.5	288.4	320.9	269.3	265.0	234.0	175.3	269.7	227.7	107.9	78.6
Protein (%)	23.5	50.5	48.0	45.1	47.9	43.6	34.6	65.2	45.5	26.8	20.9
Carbohydrate (g)	578.7	161.1	179.4	151.0	146.2	144.9	141.8	9.2	138.5	249.6	232.6
Carbohydrate (%)	61.2	28.8	25.4	26.6	26.2	27.1	29.7	2.3	27.9	62.1	61.1
Total lipids (g)	64.1	52.83	77.0	75.5	63.5	69.5	86.1	57.5	59.2	19.5	33.4
Total lipids (%)	15.2	20.6	26.5	28.2	25.8	29.1	35.5	32.4	26.5	10.9	17.9
Sodium (mg)	2593	1801	1807	1755	1973	1766	1920	1888	1559	657	3213

b.m. = body mass.

2.4. Resistance Training Protocol

The training protocol was designed and supervised by an experienced kinesiologist specialized in resistance training. The Participant completed six resistance-training sessions per week. Training was performed during the evening, and each session lasted about an hour. Briefly, on Monday, muscles from chest and calf were targeted; on Tuesday, thigh (emphasis on quadriceps muscles) and abdomen; on Wednesday, biceps and calf; on Thursday, triceps and abdomen; on Friday, thigh (emphasis on hamstrings) and calf; on Saturday, back; and Sunday was a "day off". The resting period between sets suggested was 30–60 s. Table 3 summarizes the resistance exercise used.

Table 3. Resistance training sessions carried out weekly for 11 weeks.

Monday	Sets	RM	Tuesday	Sets	RM
Bench press	3	6	Lying hamstring curl machine	1	30
Bench press (inclined)	3	6	Barbell back squat	2	4–6
Cable crossover	2	15	Barbell back squat	1	10–12
Peck deck	2	15	Lying hamstring curl machine	1	30
Standing bilateral calf raise [1]	4	20	Leg Press	2	4–6
			Leg Press [1]	2	10–12
			Stiff legged deadlift	1	15
			Knee extension machine	2	10
			Stiff legged deadlift	1	15
			Full abdominal in the machine	3	16
Wednesday	**Sets**	**RM**	**Thursday**	**Sets**	**RM**
Standing barbell curl	2	6	Lying Barbell Triceps Extension	2	6
Alternating Standing Dumbbell Biceps Curl	2	6	Lying Barbell Triceps Extension	1	12
Machine Biceps Curl [2]	4	12	Triceps Pushdown (V Bar)	2	6
Machine Biceps Curl	2	12	Triceps Pushdown (straight bar)	2	6
Hammer Curl	3	10	Supinated Triceps Pushdown (straight bar)	3	15
Wrist flexion (unilateral)	3	15	Triceps Bench Dips	2	Max
Hammer Curl	2	15	Abdominal curl machine [3]	3	16
Seated calf raise [1]	4	20			
Friday	**Sets**	**RM**	**Saturday**	**Sets**	**RM**
Knee extension machine	1	30	Pull-Ups (pronated grip)	2	Max
Lying hamstring curl machine	2	6	Lat Pulldown (triangle bar) [4]	2	10–12
Lying hamstring curl machine	1	15	Unilateral seated row (supinated grip) [4,5]	2	10–12
Knee Extension Machine	1	30	Reverse grip bent over barbell row	2	10
Barbell back squat [1]	4	12	Bent Over Barbell Row	2	10
Knee extension machine	1	30	Straight-arm pulldown	2	15
Stiff	4	15	Trunk extension	3	15
Unilateral knee flexion with shinguard	2	15			
Standing bilateral calf raise [1]	4	20			
Sunday			**Day off**		

Max: repetitions up to volitional fatigue. RM: Repetition maximum. [1] 50% of sets emphasized concentric phase and 50% of sets emphasized eccentric phase. [2] Two sets performed with supinated grip and two sets performed with semi-pronated grip. [3] Eight repetitions maximum followed by eight repetitions with reduced load. [4] After concentric fatigue, exercise was continued through eccentric contractions until eccentric-fatigue. [5] Performed unilaterally.

In the week of competition, the Participant ran twice while fasting; in the first session (Monday), the Participant ran for 20 min at 10 km/h, and in the second session (Thursday), the Participant performed interval training. He was instructed to perform six 30-s bouts at 14 km/h, interspersed with 30-s active recovery at 5.5 km/h. Intensity was defined subjectively.

2.5. Anthropometric Measurements

Height (in centimeters) and body mass (in kg) were measured with a precision of 0.1 cm and 0.1 kg, respectively. Body mass index (BMI) was calculated by dividing body mass by height squared (kg/m^2).

Skinfold thicknesses (in millimeters) were obtained from the right side of the body at seven sites (triceps, subscapular, suprailiac, chest, abdomen, thigh and midaxillary) to estimate body fat percentage using a Lange skinfold caliper (Cambridge Scientific Industries, Inc., Cambridge, MA, USA). To avoid inter-examiner variability, skinfold thicknesses were measured by the same examiner, who had been previously trained, and was experienced in the use of skinfold calipers. Skinfold measurements were carried out in duplicate, and the mean recorded value was used [13]. The Jackson and Pollock equation for male athletes was used [14]. Body density was converted to body fat percentage using the Siri equations [15]. Anthropometric assessment was performed in the 4th, 7th, 10th and 11th weeks (Table 4). Unfortunately, no data was collected before the preparatory period. The intraclass correlation coeficient (ICC) for all skinfold measurements was between 0.87 and 0.99 and the coefficient of variation (CV) for all skinfold measurements was between 0 and 4%.

Table 4. Body composition variation during 11 weeks' AAS self-administration.

Variable	Week			
	4th	7th	10th	11th
BM (kg)	81.7	80.3	78.7	76.9
BMI (kg/m^2)	26.1	25.6	25.1	24.5
ΣSF (mm)	35.5	33.5	31.5	29.0
BF%	4.5	4.1	3.8	3.4
FFM (kg) *	78.0	77.0	75.7	74.3
FFM% *	95.5	95.9	96.2	96.6

AAS: anabolic-androgenic steroids, ΣSF: sum of all skinfolds, BF%: percentage of body fat, BM: body mass, BMI: body mass index, FFM: fat-free mass, FFM%: fat free mass percentage. * The fat-free mass was estimated based on the percentage of body fat.

The Participant lost 4.8 kg (% decrease: −5.9% in body mass) between the 4th and last weeks. This decrease in body mass was accompanied by a decrease of body fat (BF; absolute decrease: −1.1kg; % decrease: −24.4%), sum of skinfolds (absolute decrease: −6.5 mm; % decrease: −18.3%) and BMI (absolute decrease: −1.6 kg/m^2; % decrease: −6.1%). Regardless of the intake of doses of AAS, fat free mass decreased by 4.7% (3.7 kg) in the same period.

3. Discussion

Here, we describe the effects of practices adopted by an amateur bodybuilder (Men's Physique category) on his body composition during the pre-competitive period of his first competition. Bodybuilders are judged by appearance rather than performance; therefore, increased muscle size and definition are critical elements of success [16]. Preparation for a bodybuilding competition ideally involves reductions in %BF and maintenance or increase in muscle mass. In the current study, despite the Participant's %BF decrease during the pre-competition period, a reduction in FFM also took place. Such results seem contradictory, since several studies show increases in body mass ranging between 2 and 5 kg of FFM when AAS is administered [17,18]. However, decreases in FFM have been also reported in bodybuilders [6].

We believe these negative outcomes were a result of a high weekly training volume adopted by the Participant, combined with a 59.5% reduction in caloric intake with 64.5% reduction in protein ingestion. It would be advisable to adopt strategies not only to gain definition, but also to preserve FFM loss.

With regard to low caloric and protein intake, studies in bodybuilders indicate that severe energy restriction significantly decreases the concentrations of anabolic hormones [19]. As a consequence, hypertrophic pathways may be impaired. Therefore, we would follow previous suggestions to lose ~0.5 kg of body mass per week in order to promote body mass reduction without activating catabolic pathways [20,21], which seems to be attainable with a caloric restriction of 300–750 kcal per day [21]. This reduction in caloric intake should be accompanied by a protein intake of around 1.2 to 2.0 g/kg, as has been previously suggested for bodybuilders [6,22].

One alternative would be adjusting training volume to account for the reduction in nutrient and caloric intake. Rebaï et al. [23] examined the effect of maintaining or reducing resistance training volume during Ramadan-intermittent-fasting on muscle strength and power of soccer players. The authors found that a reduced training volume during Ramadan-intermittent-fasting may lead to significant improvements in muscle strength and power. Therefore, it is advisable to decrease training volume and/or frequency during the caloric restriction period in order to maintain FFM. Bickel, Cross, & Bammman [24] conducted a study to test the efficacy of two maintenance training prescriptions on muscle mass, muscle fiber size, type distribution, and strength. To this end, the authors recruited 70 adults, who participated in a two-phase exercise trial that consisted of resistance training on 3 days/week for 16 weeks (phase 1), followed by a 32-week period (phase 2) with random assignment to detraining or one of two maintenance prescriptions (reducing the dose to one-third or one-ninth of that during phase 1). According to the results, muscle size can be maintained with one third of the training volume performed in phase 1.

One strategy for reducing training volume is to review exercise choice. The resistance training program adopted by the Participant had many single-joint exercises, such as bicep curls and knee extensions. Some bodybuilders and resistance training practitioners believe that single-joint exercises promote greater muscle hypertrophy than multi-joint exercises, because they are easier to learn, and therefore have less reliance on neural factors. Gentil, Soares and Bottaro [25] compared the effects of multi-joint vs. Single-joint exercises on upper body muscle size and strength gains in untrained young men. The authors found that multi-joint and single-joint exercises are equally effective for promoting increases in upper body muscle strength and size in untrained men. The use of multi-joint exercises can save time and decrease the number of exercises, which equates to training volume. Nonetheless, the addition of single-joint exercises failed to promote gains in muscle and strength of both trained [26] and untrained participants [27]. Hence, it is possible save time and prevent adverse training effects (e.g., injury and overtraining) by restricting the use of single-joint exercises [28].

In addition to resistance training, the Participant also performed two sessions of aerobic exercise while fasting at the 11th week. Bodybuilders usually perform "aerobic-fasting" training in order to potentiate fat loss. However, studies have shown that strategy to be inefficient, probably due to the decrease in energy expenditure [29] and negative interference in metabolism throughout the day [30]. Such a practice has also been linked to nausea, syncope and cerebral damage [31,32]. Therefore, exercising while fasting should be avoided, and replaced with a safer and more efficient strategy, such as high-intensity aerobic exercise while properly nourished. In addition, running appears to be more detrimental than cycling for muscle mass maintenance [33]. Hence, performing high-intensity aerobic cycling training would be adivisible [34].

The amount of AAS used by the Participant (between 790–1250 mg/week or 113–179 mg/day) is alarming, but similar to what has been reported by Gentil et al. [6] and Perry et al. [7], previously. Considering that the normal production of steroids in men is 4–11 mg/day [35,36], the dosage is 10–45 times higher than the natural androgen production. Despite the elevated amount of AAS used, the Participant did not present any acute complications associated with AAS misuse; however, we have no data about past chronic effects, or what happened after the study. There is a large body of evidence suggesting that the indiscriminate use of AAS is not safe [9,37,38], and the literature provides many cases of serious cardiovascular events associated with anabolic steroid abuse by bodybuilders [39,40]. Additionally, many studies confirm that the abuse of anabolic substances produces profound and partly irreversible changes in various organs and systems, and that these changes tend to be related to the type, duration and dosage of anabolic steroids used [40,41]. Certainly, not everybody who uses or has used AAS will present side effects; at the same time, not all effects are evident. It is therefore recommended to avoid such drugs unless prescribed by a doctor.

In addition, the high amount of ephedrine (35 mg/day) ingested by the Participant during the week preceding the championship may impose extra health risks, as the use of ephedrine has been associated with cardiovascular and central nervous systems problems [42,43].

The results of the current case are also in agreement with previous studies performed by Gentil [22] and Gentil et al. [6], who questioned the use of "bulking and cutting phases". According to the actual body of evidence, bodybuilders seem to risk their health in order to increase fat-free mass, and then again to lose fat; but end up, in fact, losing most of the fat-free mass previously gained [6,39,40]. Perhaps it would be more reasonable to gain smaller amounts of muscle mass while minimizing fat gain, and then adopting strategies for losing body fat while preserving lean mass, which would virtually eliminate the traditional preparatory and pre-competitive (also known as "bulking" and "cutting", respectively) phases and promote less aggressive variations in body composition together with less drug abuse.

A considerable limitation of the current study is the lack of baseline body composition data. Nevertheless, we believe that this limitation does not prevent the drawing of conclusions from the study.

4. Conclusions

The results of the current case showed a reduction in body mass and fat percentage of an amateur bodybuilder during the pre-competitive period, which involved 11 weeks of resistance training associated with a specific diet and AAS administration. Our analysis also showed a reduction in lean mass, which suggested mistakes in preparation, apparently caused by a combination of excessive training volumes and inadequate protein consumption. Since only the pre-competitive period was studied, other studies analyzing changes in body composition of amateur bodybuilding throughout the preparatory phase are required. Additionally, it is important to conduct studies aiming to identify the prevalence of AAS use, as well as the awareness of bodybuilders regarding the consequences of the indiscriminate use of these drugs.

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