

ORIGINAL ARTICLE

Nutritional and supplementation strategies of Spanish natural elite bodybuilders in precontest

Henar GONZÁLEZ-CANO ¹, Pablo JIMÉNEZ-MARTÍNEZ ^{1, 2 *}, Eneko BAZ-VALLE ^{1, 3},
Carlos CONTRERAS ⁴, Juan C. COLADO ², Carlos ALIX-FAGES ^{1, 2, 5}

¹Strength Training and Neuromuscular Physiology Research Center, National Strength and Conditioning Institute (ENFAF), Murcia, Spain; ²Research Group in Prevention and Health in Exercise and Sport (PHES), University of Valencia, Valencia, Spain; ³Faculty of Physical Activity and Sports Sciences, University of the Basque Country, Leioa, Spain; ⁴Faculty of Health Sciences, Catholic University of Murcia, Murcia, Spain; ⁵Applied Biomechanics and Sport Technology Research Group, Autonomous University of Madrid, Madrid, Spain

*Corresponding author: Pablo Jiménez Martínez, Research Group in Prevention and Health in Exercise and Sport (PHES), University of Valencia, Valencia, Spain. E-mail: pablojfit@gmail.com

ABSTRACT

BACKGROUND: Bodybuilders modify their nutritional strategies during precontest phase. This study aimed to explore for the first time the nutritional and supplementation strategies of high-level amateur (AMA) and professional (PRO) Spanish men's physique bodybuilders during precontest phase.

METHODS: Eleven elite male bodybuilders (6 PRO and 5 AMA) – of which 4 obtained the world champion title – enrolled in this study. All participants were drug tested before each competition (*i.e.*, urine and/or polygraph analysis) and winners after the event (blood drug testing) by Spanish Anti-Doping Agency (AEPSAD/WADA Spain). In this cross-sectional study, participants completed a modified 34-items questionnaire related to their dietetics habits, nutritional strategies and supplement consumption throughout their precontest phase. Participants recorded their food intake over a 24-hour period in grams. Dietary intakes of PRO and AMA competitors were statistically compared.

RESULTS: *t*-tests revealed that PROs reported significantly ($P<0.05$) more age, kcal/day at the start of the preparation and weight at the middle than AMAs. Pearson χ^2 tests revealed ($P<0.05$) that PROs perceived higher carbohydrates intake and used more carbohydrates supplements. Besides, while most of PROs followed a “clean diet,” most of AMAs “adjusted macronutrients” ($P=0.036$).

CONCLUSIONS: Long-term low caloric deficit diets (*i.e.*, 20-28 weeks) jointly with high protein and carbohydrate diets are the main strategies in precontest phase of natural elite AMA and PRO bodybuilders. PROs are older, heavier and trend to diet for longer periods than AMAs. PROs also perceived a highest ingest of carbohydrate and consume larger quantities of sport supplements (*e.g.*, carbohydrates).

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KEY WORDS: Hypertrophy; Resistance training; Nutritional sciences; Dietary supplements.

Bodybuilding is an aesthetics-based sport where competitors perform defined poses on stage and judges evaluate their muscular symmetry, volume and lean conditioning.¹ Recently, a special division of bodybuilding called natural bodybuilding has become popular.² In these events, drug-free practitioners (*i.e.*, without consumption of World Anti-Doping Agency banned

substances) are urine, blood and/or polygraph tested before and/or after the competition. If these athletes are drug-positive after being examined, they are banned for competition and sanctioned.² Bodybuilders often divide their season in a “bulking” phase, where they try to gain as muscle mass as possible under a caloric surplus, and a “cutting” phase (*i.e.*, precontest) in which

they try to maintain their gained muscle mass, raising extreme fat loss levels using hypocaloric diets.³ In spite of the importance of aerobic and resistance training manipulation (*e.g.*, training volume, total load, intensity), nutritional strategies are crucial in the precontest phase. However, some natural-bodybuilding athletes usually perform non-evidenced-based protocols (*e.g.*, sodium restriction) which may be unsuccessful and potentially dangerous for their health.⁴ Bodybuilders modify their macronutrient distribution (*i.e.*, protein, fat and carbohydrate intake) along their off and on-season.⁵ Professional bodybuilders trend to consume higher protein, caloric, fiber and carbohydrate-enriched diets in comparison to amateur bodybuilders.^{3, 6} Macronutrient manipulation between elite male and female bodybuilders during precontest phase includes decrements in total grams of carbohydrate (range: 3.5-5.1 g/kg BW) and fat (range: 0.5-0.8 g/kg BW) ($P<0.05$) with non-significant reductions in protein intake (range: 2.7-3.3 g/kg BW) ($P=0.09$).⁶ Caloric intake ranges in male (range: 32.7-38.2 kcal/kg BW) and female athletes (range: 29.5-32.5 kcal/kg BW)⁶ to levels where low energy availability and micronutrients deficiency may appear, producing physiological disturbances (*e.g.*, an increment in bone resorption and hormonal disruption).⁷ Of note, bodybuilders also use advanced strategies as intermittent dieting, which may improve the management of hunger, satiety and psychological stress during precontest phase.⁸ Bodybuilders also consume high rates of sport supplements (SS).⁹ SS are a group of legal substances (*i.e.*, without medical prescription or considered as banned substances) which can improve sports performance.¹⁰ These products are widely popular between different athletic populations (*e.g.*, rowers, soccer players or bodybuilders).¹¹ A recent investigation reported a very high consumption of these products between Italian bodybuilders. Data showed an 81.31% consumption among bodybuilders, with a 65.52% of men and 34.48% of women.⁹ Bodybuilders trend to consume different type of SS as creatine, protein powder, caffeine or amino acids to retain as muscle mass as possible, loss fat and improve their appearance and physical performance.^{2, 3, 6} To date, elite natural body-

builders strategies have not been well compiled several times before.⁶ In addition, World Natural Bodybuilding Federation (WNBF) is the most prestigious drug-free bodybuilding organization in the world. WNBF hosted national, international and world championships where amateur athletes may become professional after winning their professional card and professional athletes can compete against the greatest bodybuilders in the world. Thus, we had the opportunity to assemble for the first-time information about natural bodybuilders from WNBF Spain as in other regions have been done before.^{3, 6} Moreover, in this cross-sectional study, it has been collected data about amateurs, winners of professional card and world championship winners (*i.e.*, amateur and professional) Spanish athletes, including their nutritional and dietetics strategies in the different precontest phases.

Materials and methods

Design

Professional (PRO) and amateur (AMA) male natural men's physique competitors were included in this study ($N=11$). All competitors qualified to WNBF Spain championship and obtained at least a top 10 on the competition season (range: 1-9). All participants were tested before the competition and overall winners had extra testing after the events. Precontest test included a urine and polygraph test and post-contest test a blood sample analysis conducted by Spanish Anti-Doping Agency (AEPSAD). Athletes which compete in more of 1 event were tested before each competition if more than 2 weeks passed after the last test. Authors informed all participants previous to the data collection with a digital information consent sheet which was fully completed by participants. All participants complete a nutritional adaptation of a previous validated questionnaire of 34 items conducted by Chappell *et al.*,⁶ where descriptive information (*i.e.*, height, age and weight) during the off-season and precontest phases, dietary and nutritional habits, changes in body weight and SS consumption were inquired. Reported data were collected by the research team, however if invalid data or clarifications were needed it was contacted with

athletes *via* electronic mailing. Data also included nutritional strategies related to intermittent diet (e.g., intermittent fasting protocols), diet type, artificial sweeteners, the followed dietetic protocol and cheat meal (*i.e.*, meals out of their planned diet) and refeeds (*i.e.*, acute increments in calories and carbohydrate intake during precontest phase) information. After data collection using Microsoft Excel software (2019 version; Microsoft Corp., Redmond, WA, USA), results were reported jointly and separately for professional and amateur competitors. World champions winner data were also analyzed for amateur and professional athletes comparing differences between both categories.

Participant characteristics

Competitors were asked to report their precontest phase and precompetition weight (kg) (*i.e.*, before starting preparation and the precompetition day). Height (cm), age (years) and changes in weight loss measures as Body Mass Index (BMI) (kg/m²) was calculated for each participant. Of note, from all the participants (N.=11), 6 athletes became professional bodybuilders earning their pro-cards on that season. 2 of them won the professional WNBf world championship title on their height category, other 2 athletes attained the WNBf world championship in their height amateur category and turning professionals, and 3 of the competitors won the overall tittle (*i.e.*, their height category class and the all-categories winners comparison class) in 1 WNBf event of that season (*i.e.*, Italy, Ukraine and Spain). The present study was approved by the ethics committee of UCAM University (Murcia, Spain); code: CE012209, in accordance with Helsinki Declaration.

Dietary analysis

After data collection, nutritional analysis was performed with Microsoft Excel software. Macronutrients and energy intake was collected and extracted from the reported data and calculated in relative values (g/kg BW for macronutrients; kcal/kg BW for energy intake). Nutritional variables were analyzed thrice during the follow up of precontest phase (*i.e.*, before starting, at the middle, and at the end). Each participant was noticed to include dietary SS intake in their total

macronutrients and energy consumption values. Athletes were also asked about coffee, tea, energy or sweetened beverages consumption, smoking and dietetic habits.

Supplements

A 15 categories sub-questionnaire was performed. The split included "multivitamin," "vitamin C," "vitamin D," "minerals or multivitamin," joint-health supplement (e.g. curcumin, boswellia serrata, chondroitin, glucosamine)," "Omega 3," "preworkouts (*i.e.*, multi-ingredients formula)," "protein powder," "branch chain amino acids (BCAA)," "creatine," "aminoacids," "fat burners (e.g. multi-ingredients or mono-ingredients as p-synephrine, green tea extract, capsaicin or caffeine)," "protein bars," and "others" which included SS that are not related to the other categories (e.g., carbohydrates, ashwagandha, melatonin, lavender) or that subjects did not declared in other categories (e.g., capsaicin, citrulline, nitrates).

Statistical analysis

Descriptive data of the variables are presented as means and standard deviation (SD). The homogeneity of the variances (Levene's Test) was confirmed ($P > 0.05$). The normal distribution of the variables was tested by the Shapiro-Wilk Test. Where data were not normally distributed the Mann-Whitney *U* Test was implemented: 1) age; 2) BMI (competition); 3) kcal/kg (start); 4) fat/kg (start); and 5) fat/kg (middle). The Greenhouse-Geisser correction was applied when the Mauchly's Sphericity Test was significant ($P < 0.05$). Independent *t*-tests were used to identify if there was a difference in means between PRO and AMA relating to: 1) height; 2) weight (start); 3) weight (middle); 4) weight (competition); 5) total weight loss; 6) weight loss per week; 7) % weight loss; 9) % weight loss per week; 10) BMI (start); 11) weeks on diet; 12) water (L); and 13) all parametric absolute and relative kcal and macronutrients variables. Categorical variables were analyzed using the Pearson χ^2 test for: 1) artificial sweetener intake; 2) supplements usage; 3) beverage intake; and 4) diet perceptions. Statistical significance was set at $P < 0.05$. The Cohen's *d* effect size (ES) with 95% confidence intervals

was calculated to evaluate the magnitude of the differences using the following scale: negligible (<0.20), small (0.20-0.49), moderate (0.50-0.79), and large (≥ 0.80).¹² Where the Mann-Whitney *U* Test was implemented, ES was calculated by Rosenthal's *r* ($r=Z/\sqrt{N}$) and represented in absolute values.¹³ Where the Pearson χ^2 test was implemented, ES was calculated by Cramér's *V* and represented in absolute values.¹⁴ Statistical analyses were performed using the software package SPSS (SPSS version 25.0, Chicago, IL, USA). Statistical significance was set at $P<0.05$.

Results

Participant characteristics

Eleven male natural bodybuilders from the men's physique category were recruited. Five of them were high-level amateur competitors (age: 26.1 ± 2.6 years [range: 22-29 years]; body mass in competition: 81.9 ± 4.8 kg; height: 1.79 ± 4.44 m) while six were professionals (age: 23.39 ± 0.55 years [range: 22-24 years]; body mass in competition: 76.4 ± 3.7 kg; height: 1.76 ± 4.37 m). Participant characteristics including diet length and anthropometrical changes along the preparation for the competition are presented in Table I. Most of the variables did not reach significant differences between professional and amateur bodybuilders (Table I). However, professional competitors were significantly older ($P=0.045$) and heavier (at the middle of contest preparation) ($P=0.039$) than amateur competitors.

Nutrient intake

Energy and macronutrient intake in absolute and relative values (scaled for body mass) for the start, middle and end of contest preparation are reported in Table II. Significant differences between PRO and AMA competitors were only found for the kilocalories consumed per day at the start of the contest preparation ($P=0.038$). Professional competitors ate more kilocalories per day at the start of the contest preparation with a large effect size ($ES=1.47$) (Table II).

Supplements and sweeteners usage

SS and sweeteners usage of PRO and AMA competitors are reported in Table III. The only significant difference between PRO and AMA competitors was that professionals consumed moderately more carbohydrates SS (83.3%) compared to amateurs (20%) ($P=0.036$; $V=0.63$) (Table III).

Beverage intake

Coffee, tea, energy drinks, soda and alcohol intake of PRO and AMA competitors is reported in Table IV. The Pearson χ^2 test did not reveal significant differences between PROs and AMAs for any variable (P range: 0.229 to 0.693) (Table IV).

Diet perceptions

All subjects (both PROs and AMAs) reported that their perceived protein intake during the contest

TABLE I.—Characteristics of Spanish professional and amateur natural bodybuilders along the contest preparation

Variables	Bodybuilders		<i>t</i> -test	Cohen's <i>d</i> ES
	PRO	AMA		
Age	26.06 $\pm$ 2.55	23.39 $\pm$ 0.55	$P=0.045^*$	0.61 [#]
Height	179.17 $\pm$ 4.45	176.74 $\pm$ 4.37	$P=0.388$	0.55 (-0.68, 1.75)
Weight (start)	96 $\pm$ 6.93	87.9 $\pm$ 4.48	$P=0.052$	1.36 (-0.01, 2.67)
Weight (middle)	88.97 $\pm$ 5.10	82.15 $\pm$ 4.01	$P=0.039$	1.47 (0.74, 2.80)
Weight (competition)	81.93 $\pm$ 4.81	76.4 $\pm$ 3.71	$P=0.065$	1.27 (-0.08, 2.56)
Total weight loss	14.07 $\pm$ 6.17	11.5 $\pm$ 1.80	$P=0.396$	0.54 (-0.69, 1.74)
Weight loss per week	0.52 $\pm$ 0.28	0.60 $\pm$ 0.18	$P=0.628$	-0.30 (-1.49, 0.90)
% Weight loss	14.43 $\pm$ 5.90	13.06 $\pm$ 1.76	$P=0.631$	0.30 (-0.90, 1.49)
% Weight loss per week	0.53 $\pm$ 0.26	0.68 $\pm$ 0.23	$P=0.338$	-0.61 (-1.82, 0.62)
BMI (start)	29.92 $\pm$ 2.18	28.13 $\pm$ 0.46	$P=0.107$	1.08 (-0.23, 2.34)
BMI (competition)	25.52 $\pm$ 1.01	24.45 $\pm$ 0.12	$P=0.067^*$	0.21 [#]
Weeks on diet	28.33 $\pm$ 6.62	20.4 $\pm$ 5.68	$P=0.065$	1.28 (-0.07, 2.57)

Mean $\pm$ standard deviation.

* P calculated by Mann-Whitney *U* Test; [#]ES calculated by Rosenthal's *r*.

PRO: professional bodybuilders; AMA: amateur bodybuilders; ES: effect size.

TABLE II.—*Nutrient intake of Spanish professional and amateur natural bodybuilders along the contest preparation.*

Variables	Bodybuilders		<i>t</i> -test	Cohen's <i>d</i> ES
	PRO	AMA		
Water (L)	4±1.38	4.3±1.35	P=0.725	-0.22 (-1.41, 0.98)
kcal/day (start)	3637±677.31	2809±369.70	P=0.038	1.47 (0.08, 2.81)
kcal/kg (start)	38.03±7.91	31.91±3.46	P=0.100*	0.18 [#]
Protein/kg (start)	2.4±0.46	2.22±0.29	P=0.465	0.46 (-0.76, 1.66)
Fat/kg (start)	0.88±0.37	0.66±0.21	P=0.309*	0.11 [#]
Carbohydrates/kg (start)	5.13±0.88	4.28±0.85	P=0.138	0.99 (-0.31, 2.23)
kcal/day (middle)	2870±192.8	2711±539.9	P=0.515	0.41 (-0.80, 1.60)
kcal/kg (middle)	32.33±2.47	32.97±6.29	P=0.821	-0.14 (-1.33, 1.05)
Protein/kg (middle)	2.43±0.27	2.4±0.39	P=0.871	0.10 (-1.09, 1.29)
Fat/kg (middle)	0.78±0.24	0.68±0.04	P=0.774*	0.03 [#]
Carbohydrates/kg (middle)	3.93±1.07	4.24±1.29	P=0.677	-0.26 (-1.45, 0.94)
kcal/day (end)	2667.5±355.24	2419.6±490.66	P=0.356	0.59 (-0.64, 1.79)
kcal/kg (end)	32.61±4.37	31.69±6.42	P=0.786	0.17 (-1.03, 1.35)
Protein/kg (end)	2.55±0.22	2.48±0.50	P=0.761	0.19 (-1.01, 1.38)
Fat/kg (end)	0.63±0.15	0.52±0.15	P=0.242	0.76 (-0.50, 1.98)
Carbohydrates/kg (end)	4.2±0.86	3.96±1.60	P=0.757	0.19 (-1.00, 1.38)

Mean±standard deviation.

*P calculated by Mann-Whitney *U* Test; [#]ES calculated by Rosenthal's *r*.

PRO: professional bodybuilders; AMA: amateur bodybuilders; ES: effect size.

TABLE III.—*Use of supplements and sweeteners in Spanish professional and amateur natural bodybuilders along the contest preparation.*

Variables	Bodybuilders		Pearson χ^2 test	Cramer's <i>V</i>
	% PRO	% AMA		
Sweeteners	100	80	P=0.251	0.346
Multivitaminic	16.7	0	P=0.338	0.289
Vitamin C	16.7	20	P=0.887	0.043
Vitamin D	50	0	P=0.064	0.559
Minerals	0	40	P=0.087	0.516
Joint-health supplement	16.7	0	P=0.338	0.289
Omega 3	33.3	20	P=0.621	0.149
Whey protein	83.3	60	P=0.387	0.261
BCAAs	0	0	-	-
EAAAs	16.7	0	P=0.338	0.289
Carbohydrates	83.3	20	P=0.036	0.633
Creatine	83.3	60	P=0.387	0.261
Fat burners	50	40	P=0.740	0.100
Preworkouts	50	20	P=0.303	0.311
Protein bars or flapjacks	0	0	-	-

%: consumption percentage; PRO: professional bodybuilders; AMA: amateur bodybuilders.

preparation was “high” (100%). The Pearson χ^2 revealed significant differences for the perception of carbohydrates intake when comparing PROs and AMAs ($P=0.036$; $V=0.63$). 83.3% of the PRO competitors reported that they had “high” carbohydrates intake during the contest preparation while 16.7% perceived a “medium” carbohydrates consumption. For AMAs, while 20% considered their carbohydrates intake as “high,” 80% described it as “medium.” No significant differences were found for fat intake

perception ($P=0.303$; $V=0.31$). 50% of professionals considered that their level of fat intake was “medium” while the other 50% considered it “low.” For AMAs, 20% of them reported “medium” levels of perceived fat intake while 80% considered it “low.” No competitor of both PRO and AMA groups used “cheat meals” during the contest preparation diet (0%). The Pearson χ^2 revealed significant differences for the perceived kind of diet between PRO and AMA competitors ($P=0.036$; $V=0.63$). 83.3% of PROs

TABLE IV.—*Beverage intake of Spanish professional and amateur natural bodybuilders along the contest preparation.*

Variables	Period	Bodybuilders		Pearson χ^2 test	Cramer's V
		%PRO	%AMA		
Coffee	<1/month	33.3	20	P=0.693	0.364
	1-3/month	0	0		
	1/week	16.7	0		
	2-4/week	0	0		
	5-6/week	0	0		
	1/day	16.7	20		
	2-3/day	33.3	60		
Tea	<1/month	83.3	40	P=0.264	0.690
	1-3/month	0	20		
	1/week	0	20		
	2-4/week	0	0		
	5-6/week	0	20		
	1/day	0	0		
	2-3/day	16.7	0		
Energy drinks	<1/month	33.3	20	P=0.229	0.715
	1-3/month	33.3	20		
	1/week	0	0		
	2-4/week	0	60		
	5-6/week	0	0		
	1/day	16.7	0		
	2-3/day	16.7	0		
Soda	<1/month	50	60	P=0.422	0.671
	1-3/month	16.7	0		
	1/week	0	20		
	2-4/week	16.7	0		
	5-6/week	16.7	0		
	1/day	0	20		
	2-3/day	0	0		
Alcohol	<1/month	100	80	P=0.251	0.346
	1-3/month	0	20		
	1/week	0	0		
	2-4/week	0	0		
	5-6/week	0	0		
	1/day	0	0		
	2-3/day	0	0		

%; consumption percentage; PRO: professional bodybuilders; AMA: amateur bodybuilders.

considered that they followed a “clean diet” during the contest preparation while 16.7% of them considered that they dieted by “adjusting macronutrients.” For AMA competitors, 20% reported “clean diet” while 80% reports “adjusting macronutrients.”

Discussion

Research related to natural bodybuilders nutritional and supplementation strategies have not been documented for Spanish population before in peer-reviewed literature. Although previous studies had explored natural bodybuilders

in other national samples,^{3, 6} most of those interventions documented case-studies.^{15, 16} Our data found similar evidenced-based strategies² in PRO and AMA natural elite bodybuilders, however, professional bodybuilders trends to diet for more weeks (pro: 28.33 ± 6.62 ; amateur: 20.40 ± 5.68) ($P=0.065$; $ES=1.28$). and consume larger quantities of calories in absolute value due to their higher weight (Table I) but not in relative (*i.e.*, kcal/kg BW). Non-significant differences were reported in SS conditions except in carbohydrates consumption, higher in the PRO group ($P=0.036$). A positive trend was also observed for vitamin D ($P=0.064$; Cra-

mer's $V=0.559$). Of note, surprisingly water ($P=0.725$) and carbohydrate dietetic consumption ($P=0.677$) did not differ between PRO and AMA athletes. None of the participants of any of the groups reported cheat meals. Both groups perceived their diet as clean or adjusted to macronutrients, which means that the behavior of these competitors was more flexible than other studies described before.¹⁷

Dietary intake

Energy intake

Bodybuilders modulate their energy intake through caloric surplus or deficit during the different season phases (*i.e.*, "bulking" or precontest).¹⁸ As expected, energy intake at the start of precontest phase was higher than middle and end cut-off points. Significant differences were reported between PRO and AMA athletes, consuming PROs more calories through all the precontest. However, weight and age differences were also significant for PRO and AMA athletes which may exert a moderator effect in caloric intake.^{19, 20} This means that PRO bodybuilders as a consequence of being older and having more training experience, may have gained more muscle mass and they may afford higher caloric intakes. As literature reported before, dietetic and energy consumption of bodybuilders vary widely (*i.e.*, more than 1000 kcal in this data) between subjects, thus, general recommendations are not easy to assets.²¹ Although bodybuilders program resistance training to counteract catabolic body-state, energy restriction may be the main factor in muscle preservation during a weight loss preparation phase.^{22, 23} As mentioned by Roberts *et al.*,²⁰ total weeks of preparations have increased in the last 40 years ranging from 12 weeks until more than 32 weeks.¹⁵ Our data suggest that natural bodybuilders trend to manage long-term caloric deficits (range: 20-28 weeks), being PRO athletes, which enrolled dieting for more time (pro: 28.33 ± 6.62 ; amateur: 20.40 ± 5.68) ($P=0.065$; $ES=1.28$). In spite of no-drug-free bodybuilders include testosterone and other pharmacological agents during caloric deficit minimizing lean body mass loss,²⁴ lean body mass preservation

is also predicted by the amount of caloric deficit and body "stressors" (*i.e.*, overtraining or sleep deprivation).²⁵ Accordingly, in our data PRO bodybuilders not only spent more time in preparation phase, of note, their caloric restriction pattern is different than AMA bodybuilders. PROs strategy includes a higher caloric reduction at the start (*i.e.*, when their body percentage is higher), trying to maintain or increase their calories during the last weeks for preserving as muscle mass as possible. This strategy, known as reserve diet,²³ may be implemented to produce an anticatabolic effect as a consequence of energetic deficit gap reduction. Reverse diet may be often accompanied by aerobic training decrease, modulating overall caloric expenditure. Collectively, as total weeks were fewer for AMA bodybuilders, a long reverse diet phase could not be achieved, and muscle reductions might hypothetically be increased in comparison to PRO athletes.

Protein intake

Protein has been proposed as the main macronutrient for increasing muscle mass in healthy subjects.²⁶ Protein ingestion recommendations range between 1.4-2.0 to 3.0 g/kg BW/day for healthy adults involved in resistance training.²⁷ Range values may consider the net energetic state of the athlete (*i.e.*, deficit or caloric surplus), body fat levels and training variables as non-exercise activity thermogenesis (NEAT) or total resistance training volume, intensity and frequency.^{2, 26} Accordingly, WNBf Spain elite competitors' intake were in concordance with previous research in the field and consensus values.^{3, 28} In fact, protein intake and protein enriched diets jointly with as high as possible caloric intake are common strategies in competitive bodybuilders to preserve muscle mass during an extreme weight loss period.² Bodyweight trends to be reduced during the precontest season, as a consequence, relative protein values (*i.e.*, g/kg BW/day) might be increased without absolute changes. However, our data suggest that Spanish bodybuilders trend to maintain or slightly reduce their protein ingestion, moderating the expected reductions in carbohydrate and fats. In consonance, as proposed by Chap-

pell *et al.*,³ the satiating effect of protein and the increment of thermic effect of food (TEF) from 3% for fat to 20-30% of protein, may be extra major reasons for bodybuilders to choose enriched protein diets during precontest phase. As expected, natural bodybuilders hyperproteic diets were lower than protein intake in no-drug-free bodybuilders reported in literature (*e.g.*, 3.7 g/kg),²⁹ which might enroll in different dietetic practices due to the higher levels of androgens.³⁰ Of note, “protein fever” may be deleterious for athletes when focused on protein intake remove from their diet other macronutrient or micronutrient sources. In addition, our data suggest that natural elite AMA and PRO Spanish bodybuilders trend to consume adequate protein intake during long-term and extreme body fat weight loss phase.

Carbohydrate and fat intake

Carbohydrate was the main macronutrient at the start, in the middle and in the end of the preparation in AMA and PRO athletes. Carbohydrate ingestion for most athletes was in consonance with previous evidenced-based recommendations for bodybuilders.² Relative carbohydrate intake was higher in the PRO group at the start and in the end compared to AMA group, however, AMA athletes maintained their relative carbohydrate intake in the middle of the preparation. Although reductions in carbohydrate intake were observed, PRO bodybuilders increased their intake at the end as part of their reverse diet.²³ These final changes were not observed in AMA bodybuilders, which may be explained because of higher fat percentage at the last weeks, shorter precontest phases and lower caloric intake as we mentioned above. Peak-week (*i.e.*, last week's manipulations of water, carbohydrates and sodium strategies) may be structured through a longer-term model in the professional group increasing their carbohydrate intake for several weeks and shorter-term or one week peak-week in the amateur group.³¹ Although reducing carbohydrates is a common strategy and energy balance is the main regulator of weight loss, low carbohydrate diets have been reported to decrease lean body mass through water reductions and proteoly-

sis.⁶ Thus, bodybuilders might trend to preserve their carbohydrate intake during last weeks, when muscle mass retention is harder and as a consequence of caloric deficit and high aerobic exercise, resistance training performance might be compromised.^{32, 33} Furthermore, low fat diets have been associated with reductions in testosterone and hormonal parameters in athletes;³⁴ however low carbohydrate diet is also related with low-energy availability, metabolic and hormonal health disbalances and reductions in sport performance.³⁵ In the present study, fat intakes oscillate between 0.8 and 0.5 g/kg BW/day with a higher trend in the PRO group in comparison to AMAs. Accordingly, previous research has varied widely between fat intakes conditions, which means that optimal bodybuilding nutritional strategies are perceived different between athletes.^{3, 6, 19} Some research in American natural bodybuilders have prioritized higher fat intakes, specifically during 1980's and 90's.⁶ However, in their previous analysis in natural British bodybuilders and this cohort of Spanish bodybuilding elite athletes, higher levels of carbohydrates were chosen for the competitors.

Water and beverage consumption

No significant differences related to water, sweeteners or beverage consumption were reported between AMAs and PROs. Of note, the reduction in the number of athletes who consumed soda, alcohol or energy drinks varied in both groups during precontest phase. A reduction in alcohol consumption was observed for the last 5-6 weeks prior to competition. At this time, none of the athletes include alcohol in their beverage ingestion. Surprisingly, athletes rejected to consume energy drinks during all the precontest phase but minor of them included both during the days before the event. Coffee was incorporated to athlete's beverage consumption during the 3 days previous to the event, which is curious because of some adverse gastrointestinal symptom might appeared.

Supplementation strategies

High rates of SS consumption were found for whey protein (range: 60.0-83.3%) and creatine (range: 60.0-83.3%). Only carbohydrates SS in-

take which favored the PRO group was statistical difference between conditions ($P=0.036$) and a positive trend was also observed in vitamin D in the PRO group ($P=0.064$). The second most prevalent SS consumed were fat burners and preworkouts, subjects also declared some individual's substances as p-synephrine, capsaicin (*i.e.*, phenyl-capsaicin form), nitrates and citrulline malate which were assigned to the previous categories. The reason of including these new components may be related to maintaining their performance during resistance training and to increase fat metabolism. Accordingly, some of these components like capsaicinoids have demonstrated to increase repetitions until failure and improvements in performance during exhaustion resistance training tasks.³⁶ In this context, the purpose of including this kind of ergogenic aids might be related to counteract the severe fatigue induced by the caloric deficit. Thus, 4 of 11 participants have taken a capsaicin analogue (phenyl-capsaicin) during their precontest phase when high intensity training was programmed. On the other hand, the use of SS as p-synephrine or green tea extract might be related to increase fat oxidation when low intensity aerobic exercise (*i.e.*, 60% $\dot{V}O_{2max}$) is performed.^{37, 38} This means that not only caffeine and often multi-ingredients formula are used by natural elite Spanish bodybuilders to improve body composition. Regarding BCAAs supplementation, none of the athletes reported using them during the entire contest prep, being one of the most used SS in bodybuilding.⁵ Normally BCAAs are used to increase muscle protein synthesis or decrease muscle protein breakdown during energy restriction periods. The lack of the other essential amino-acids, that are necessary to meet the goal proposed by the BCAAs might be enough to question its recommendation.³⁹ This might suggest an evidence-based approach by Spanish natural bodybuilders. Finally, a minority of athletes declared the use of anti-anxiety or sleep aids during precontest as melatonin, lavender (*i.e.*, with high content of linalool), and ashwagandha (*i.e.*, high withanolides source). Moreover, these findings suggest that natural bodybuilders not only incorporate fat burners or pretraining formula and health-related ergogenic aids are commonly used.

Limitations of the study

Although reporting nutritional data may be accurate, qualitative analysis of food sources and micronutrients intake were not reported by the competitors. Other limitation is related to the low sample size, however, as mentioned above, most of the previous study in this field are case studies because of the difficult to enroll this type of athletes in these interventions. Finally, the method to collect information was questionnaire and athletes or their coach may not have standardized their intakes or under or over-estimation could appear in the quantitative and qualitative analysis.

Conclusions

In spite of significant differences appeared between AMA and PRO Spanish elite bodybuilders, most of them added to their strategies scientific evidenced-based tools. PRO bodybuilders are older, significantly heavier and diet for several more weeks. However, common links were found between protocols and general macronutrient distributions between both conditions. On the other hand, PRO bodybuilders trend to reverse diet with higher carbohydrates rates during the last weeks prior to competition in comparison to AMA bodybuilders. As a consequence, carbohydrate and energetic gap are reduced for the last weeks of precontest phase which might exerts and anticatabolic effect. PRO bodybuilders also trend to consume higher quantities of SS, including intra-workout carbohydrates and vitamin D. Furthermore, long dieting with low caloric deficit and high intakes of carbohydrates and protein seems the main practical applications of this cross-sectional study. In concordance, future research in this population might be performed to ensure this finding.

References

1. Alves RC, Prestes J, Enes A, de Moraes WM, Trindade TB, de Salles BF, *et al.* Training Programs Designed for Muscle Hypertrophy in Bodybuilders: A Narrative Review. *Sports (Basel)* 2020;8:149.
2. Helms ER, Aragon AA, Fitschen PJ. Evidence-based recommendations for natural bodybuilding contest preparation: nutrition and supplementation. *J Int Soc Sports Nutr* 2014;11:20.

3. Chappell AJ, Simper T, Helms E. Nutritional strategies of British professional and amateur natural bodybuilders during competition preparation. *J Int Soc Sports Nutr* 2019;16:35.
4. Mitchell L, Hackett D, Gifford J, Estermann F, O'Connor H. Do Bodybuilders Use Evidence-Based Nutrition Strategies to Manipulate Physique? *Sports (Basel)* 2017;5:76.
5. Lenzi JL, Teixeira EL, de Jesus G, Schoenfeld BJ, de Salles Painelli V. Dietary Strategies of Modern Bodybuilders During Different Phases of the Competitive Cycle. *J Strength Cond Res* 2021;35:2546–51.
6. Chappell AJ, Simper T, Barker ME. Nutritional strategies of high level natural bodybuilders during competition preparation. *J Int Soc Sports Nutr* 2018;15:4.
7. Logue DM, Madigan SM, Heinen M, McDonnell SJ, Delahunt E, Corish CA. Screening for risk of low energy availability in athletic and recreationally active females in Ireland. *Eur J Sport Sci* 2019;19:112–22.
8. Peos JJ, Norton LE, Helms ER, Galpin AJ, Fournier P. Intermittent Dieting: Theoretical Considerations for the Athlete. *Sports (Basel)* 2019;7:22.
9. Montuori P, Loperto I, Paolo C, Castrianni D, Nubi R, De Rosa E, *et al.* Bodybuilding, dietary supplements and hormones use: behaviour and determinant analysis in young bodybuilders. *BMC Sports Sci Med Rehabil* 2021;13:147.
10. Maughan RJ, Burke LM, Dvorak J, Larson-Meyer DE, Peeling P, Phillips SM, *et al.* IOC consensus statement: dietary supplements and the high-performance athlete. *Br J Sports Med* 2018;52:439–55.
11. Sánchez-Oliver AJ, Domínguez R, López-Tapia P, Tobal FM, Jodra P, Montoya JJ, *et al.* A survey on dietary supplement consumption in amateur and professional rugby players. *Foods* 2020;10:E7.
12. Cohen J. Statistical power analysis for the behavioral sciences. Second Edition. Hillsdale, NJ: Lawrence Erlbaum Associates; 1988. p.567.
13. Rosenthal R. Meta-analytic procedures for social research. Applied Social Research Methods Series 6. Newbury Park, CA: Sage Publications; 1991.
14. Cramer H. Mathematical methods of statistics (PMS-9). Princeton: Princeton, NJ: Princeton University Press; 1946.
15. Pardue A, Trexler ET, Sprod LK. Case Study: Unfavorable But Transient Physiological Changes During Contest Preparation in a Drug-Free Male Bodybuilder. *Int J Sport Nutr Exerc Metab* 2017;27:550–9.
16. Robinson SL, Lambeth-Mansell A, Gillibrand G, Smith-Ryan A, Bannock L. A nutrition and conditioning intervention for natural bodybuilding contest preparation: case study. *J Int Soc Sports Nutr* 2015;12:20.
17. Devrim A, Bilgic P, Hongu N. Is There Any Relationship Between Body Image Perception, Eating Disorders, and Muscle Dysmorphic Disorders in Male Bodybuilders? *Am J Men Health* 2018;12:1746–58.
18. Iraki J, Fitschen P, Espinar S, Helms E. Nutrition recommendations for bodybuilders in the off-season: A narrative review. *Sports (Basel)* 2019;7:1–19.
19. Spendlove J, Mitchell L, Gifford J, Hackett D, Slater G, Copley S, *et al.* Dietary Intake of Competitive Bodybuilders. *Sports Med* 2015;45:1041–63.
20. Roberts BM, Helms ER, Trexler ET, Fitschen PJ. Nutritional Recommendations for Physique Athletes. *J Hum Kinet* 2020;71:79–108.
21. Halliday TM, Loenneke JP, Davy BM. Dietary Intake, Body Composition, and Menstrual Cycle Changes during Competition Preparation and Recovery in a Drug-Free Figure Competitor: A Case Study. *Nutrients* 2016;8:740.
22. Sardeli AV, Komatsu TR, Mori MA, Gáspari AF, Chacon-Mikahil MP. Resistance training prevents muscle loss induced by caloric restriction in obese elderly individuals: A systematic review and meta-analysis. *Nutrients* 2018;10:4–6.
23. Trexler ET, Smith-Ryan AE, Norton LE. Metabolic adaptation to weight loss: implications for the athlete. *J Int Soc Sports Nutr* 2014;11:7.
24. Pasiakos SM, Berryman CE, Karl JP, Lieberman HR, Orr JS, Margolis LM, *et al.* Effects of testosterone supplementation on body composition and lower-body muscle function during severe exercise- and diet-induced energy deficit: A proof-of-concept, single centre, randomised, double-blind, controlled trial. *EBioMedicine* 2019;46:411–22.
25. Viana R, Gentil P, Brasileiro E, Pimentel G, Vancini R, Andrade M, *et al.* 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. *J Funct Morphol Kinesiol* 2017;2:1–9.
26. Morton RW, Murphy KT, McKellar SR, Schoenfeld BJ, Henselmans M, Helms E, *et al.* A systematic review, meta-analysis and meta-regression of the effect of protein supplementation on resistance training-induced gains in muscle mass and strength in healthy adults. *Br J Sports Med* 2018;52:376–84.
27. Jäger R, Kerksiek CM, Campbell BI, Cribb PJ, Wells SD, Skwiat TM, *et al.* International Society of Sports Nutrition Position Stand: protein and exercise. *J Int Soc Sports Nutr* 2017;14:20.
28. Jang A, Kim D, Sung KS, Jung S, Kim HJ, Jo C. The effect of dietary α -lipoic acid, betaine, l-carnitine, and swimming on the obesity of mice induced by a high-fat diet. *Food Funct* 2014;5:1966–74.
29. Amanda A, Igor B, Mauricio Schüler N, Rafael L. Nutritional and Pharmacological Strategies of Bodybuilders in Preparation Period for Competition. *Int J Sports Exerc Med* 2018;4:1–7.
30. Hartgens F, Kuipers H. Effects of androgenic-anabolic steroids in athletes. *Sports Med* 2004;34:513–54.
31. Chappell AJ, Simper TN. Nutritional peak week and competition day strategies of competitive natural bodybuilders. *Sports (Basel)* 2018;6:E126.
32. Torres M, Trexler ET, Smith-Ryan AE, Reynolds A. A mathematical model of the effects of resistance exercise-induced muscle hypertrophy on body composition. *Eur J Appl Physiol* 2018;118:449–60.
33. Fyfe JJ, Bishop DJ, Zacharewicz E, Russell AP, Stepto NK. Concurrent exercise incorporating high-intensity interval or continuous training modulates mTORC1 signaling and microRNA expression in human skeletal muscle. *Am J Physiol Regul Integr Comp Physiol* 2016;310:R1297–311.
34. Whittaker J, Wu K. Low-fat diets and testosterone in men: systematic review and meta-analysis of intervention studies. *J Steroid Biochem Mol Biol* 2021;210:105878.
35. Wasserfurth P, Palmowski J, Hahn A, Krüger K. Reasons for and Consequences of Low Energy Availability in Female and Male Athletes: Social Environment, Adaptations, and Prevention. *Sports Med Open* 2020;6:44.
36. de Moura E Silva VE, Cholewa JM, Billaut F, Jäger R, de Freitas MC, Lira FS, *et al.*; de Moura e Silva. Capsaicinoid

and capsinoids as an ergogenic aid: A systematic review and the potential mechanisms involved. *Int J Sports Physiol Perform* 2021;16:464–73.

37. Gutiérrez-Hellín J, Del Coso J. Acute p-synephrine ingestion increases fat oxidation rate during exercise. *Br J Clin Pharmacol* 2016;82:362–8.

38. Dean S, Braakhuis A, Paton C. The effects of EGCG on fat oxidation and endurance performance in male cyclists. *Int J Sport Nutr Exerc Metab* 2009;19:624–44.

39. Wolfe RR. Branched-chain amino acids and muscle protein synthesis in humans: myth or reality? *J Int Soc Sports Nutr* 2017;14:30.

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