Dietary habits and serum lipids of a group of German amateur bodybuilders

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Ernährungsgewohnheiten und Serumlipide bei einer Gruppe von deutschen Amateur-Bodybuildern

Summary: Dietary intake, nutrient supplementation, and serum lipids were investigated in 13 German male amateur bodybuilders during a non-competitive period. Dietary information was collected with weighed food records during 14 consecutive days. Daily energy intake was 17.1 ± 3 MJ including 22 ± 5 % protein, 26 ± 6 % fat, and 49 ± 4 % carbohydrates. "Breads and cereals" and "milk and dairy products" revealed to be the most important food groups. Protein supplements contributed 13 % of total protein intake. With food alone the average supply of the vitamins A, D, E and B_1 was < 3/4 of the recommended amounts (DGE). Due to the high consumption of supplement preparations, total daily intake of most of the selected minerals and vitamins – particularly of vitamins of the B-group – increased far above recommended dietary intake. Mean fasting serum triglyceride, phospholipid and total cholesterol concentrations were in a normal range, while high-density lipoprotein cholesterol levels were reduced. The serum cholesterol ester fatty acids analysis confirmed a rather low intake of essential fatty acids (linoleic acid) found by dietary assessment. In conclusion, with a few corrections in food selection patterns of the bodybuilders, a well balanced diet would be achieved and the use of nutrient supplementation products would become totally superfluous.

Zusammenfassung: Bei 13 deutschen Amateur-Bodybuildern wurde in einer Nicht-Wettkampfphase die Nährstoffzufuhr, der Einsatz von Nahrungsergänzungspräparaten sowie ausgewählte Serumlipide erfaßt. Der gesamte Verzehr wurde mit Hilfe einer Wiege-Protokoll-Methode über einen Zeitraum von 14 Tagen erhoben. Die durchschnittliche tägliche Energiezufuhr betrug 17,1 ± 3 MJ, wobei 22 ± 5 % aus Protein, 26 ± 6 % aus Fett und 49 ± 4 % aus Kohlenhydraten stammten. Die wichtigsten Lebensmittelgruppen waren ‚Getreideerzeugnisse, Brot und Backwaren' sowie ‚Milch und Milchprodukte'. Eiweißpräparate lieferten durchschnittlich 13 % der Gesamteiweißzufuhr. Mit Lebensmitteln allein wurden von den Vitaminen A, D, E und B_1 im Mittel < 3/4 der Empfehlungen (DGE) aufgenommen. Infolge des hohen Verzehrs an Nahrungsergänzungspräparaten erreichte die tägliche Zufuhr der meisten der untersuchten Mineralstoffe und Vitamine – insbesondere der B-Vitamine – Werte weit über den empfohlenen Nährstoffzufuhrmengen. Die durchschnittlichen Konzentrationen an Triglyceriden, Phospholipiden und Gesamtcholesterol im Nüchternserum bewegten sich im Normalbereich, während die HDL-Cholesterolgehalte erniedrigt waren. Das Fettsäuremuster der Serum-Cholesterolester bestätigte die geringe Zufuhr essentieller Fettsäuren (Linolsäure) während der Erhebungsphase. Insgesamt könnten die untersuchten Bodybuilder mit wenigen Korrekturen in der Lebensmittelauswahl eine ausgewogene Ernährung erreichen und somit den Einsatz von Nahrungsergänzungspräparaten vollständig überflüssig werden lassen.

Key words: Strength athletes – dietary intake – dietary supplements – serum lipids – serum fatty acids

Schlüsselwörter: Kraftsportler – Nährstoffaufnahme – Nahrungsergänzungspräparate – Serumlipide – Serumfettsäuren

Introduction

Many bodybuilders seem to fear that their nutrient requirements could not be fullfilled by means of ordinary foodstuffs. As a consequence, their dietary habits are extraordinary and the use of nutrient supplementation products is apparently indispensable (13, 28). Most studies investigating the dietary practice of bodybuilders were conducted in the USA, often dealing with special precontest strategies of these athletes (21, 22, 27, 28, 32–34, 36, 37). Data for German bodybuilders, however, are scant. Since the German sports nutrition market also offers numerous products (8), differing dietary behaviour of German athletes can be expected. In order to get more insight into food selection patterns and the amount of nutrients supported by food, a group of German amateur bodybuilders was observed during the non-competitive period. Additionally, special interest was paid to the role of nutrient supplementation products in nutritional practice of these athletes. With respect to studies, which reported, on the one hand, a very low fat intake of bodybuilders during precontest periods (21, 37) and, on the other, a high cholesterol consumption (13, 28), parameters of fat metabolism were analyzed as well.

Materials and methods

Subjects

Thirteen male amateur bodybuilders aged 19–36 years (24.6 ± 4.2 y) were studied in the non-competitive period. During the investigation period the subjects were requested to follow their regular eating pattern and weight training program (6.4 ± 0.3 h/week). On the average the subjects had regularly trained for 4.5 years (at least 2.5 y) before the beginning of the investigation. Anthropometric characteristics of the bodybuilders are listed in Table 1. All subjects were healthy according to their medical histories and had given informed consent prior to the study. Four men stated to participate regularly in body building competitions; four subjects declared to use anabolic steroids. Two groups of steroid and non-steroid using bodybuilders could not be formed because of the poor reliability of self-stated anabolic steroid intake.

Table 1. Anthropometric data of 13 German amateur bodybuilders

Parameter		Mean ± SD
Height	(cm)	180.0 ± 6.5
Weight	(kg)	89.3 ± 8.4
Broca index	(%)	112.0 ± 8.0
Body mass index	(kg/m^2)	27.4 ± 1.9
Triceps skinfold*)	(mm)	8.0 ± 3.2
Body fat§*)	(%)	15.4 ± 3.9
Lean body mass$	(kg)	75.3 ± 5.3
Circumferences#	(cm)	
Upper arm, relaxed		37.9 ± 2.1
Forearm, relaxed		32.0 ± 1.2
Thigh, relaxed		59.1 ± 6.1
Calf, relaxed		40.5 ± 2.0
Thorax, exhaled		109.4 ± 6.6

*) Skinfold thickness measurements were performed with a Harpender skinfold caliper (Holtain Ltd., Crosswell, UK); § calculated from four skinfold thicknesses (triceps, subscapular, chest/mid-axiliar, suprailiac) according to (30); $ lean body mass (kg) = weight (kg) – body fat (kg); # measured with a flexible tape with the subject in standing position

Dietary information

Dietary information was collected over a period of 14 consecutive days using the weighed record technique (4). Exceptions were made where weighing would have interfered with normal eating habits, e.g., when eating in a restaurant portions and kinds of food had to be described as exactly as possible. Recordings were made on standard forms following an intensive personal instruction; also, detailed instruction lists were handed out to every participant. Records were examined twice a week in the presence of the investigated person by a trained dietitian. Nutrient intake was analyzed by means of the computer program PRODI 3^+ (Wissenschaftliche Verlagsgesellschaft, Stuttgart, FRG) with food composition tables of Souci et al. (35) as data base. Average vitamin losses during food storage and preparation were considered (10). Supplements were recorded with their full commercial names, and the manufacturers' information was used to attain nutrient composition.

Serum analysis

Blood samples were collected at the last day of the observation period after overnight fasting. In the serum samples the concentrations of triglycerides (TG), phospholipids (PL), total cholesterol (TC), free cholesterol and high-density lipoprotein cholesterol (HDL-C) were analyzed by enzymatic procedures using Precilip and Precinorm L as reference agents (all reagents from Boehringer Mannheim GmbH, Mannheim/FRG).

After an extraction procedure (15) the serum lipids were separated by means of thin layer chromatography using petrol ether/ethylmethylketone/acetic acid = 84/15/1 (v/v/v) as solvent agent. Fatty acid methyl ester (FAME) of TG and PL were obtained by transesterification with TMSH (5) and with methanolic HCl:acetic acid methyl ester (1/2, v/v) in the case of cholesterol esters (CE). FAME mixture were separated by means of a CP-Sil-88 (Chrompack, Frankfurt/FRG) capillary column, installed in a HP 5890 gas chromatograph with a mass selectiv detector (Hewlett Packard, Taufkirchen, FRG). For identification and quantification of the FAME peaks, standard reagents of analytical grade (p.a.) were used. Fatty acid results were compared to age, sex, and BMI (body mass index) matched control subjects (n = 7) by means of an unpaired *t*-test ($p \leq 0.001$, $p \leq 0.01$, $p \leq 0.05$).

Results

Dietary intake

Average daily energy intake of the bodybuilders was 17.1 ± 3.0 MJ; fat contributes 26 ± 6 energy-% (Table 2), including 11.4 ± 7.7 g polyunsaturated fatty acids (PUFA). For protein consumption a mean value of 2.45 ± 0.95g*kg body weight^{-1}*day^{-1} or 22 ± 5 energy-% was obtained. The average contribution of alcohol to the total daily energy intake was less than 1 %. During the study mean body weight of the subjects did not change.

As indicated by the standard deviations, there was a wide range in the total intake of vitamins and minerals (Table 3). In the group of vitamins the difference between the total intake and the intake from food alone was striking. Particularly the B complex vitamins were consumed to a large extent (> 40 % of total intake) as supplement preparations (Fig. 1). In contrast, the contribution of nutrient supplements to the total intake of energy, macronutrients and minerals was comparably low (Figs. 1 and 2); only protein and iron intake by supplement preparations amounted > 10 % of total intake. In the

Table 2. Daily intake of energy and selected nutrients of 13 German amateur bodybuilders

Nutrient		Daily intake		
		Mean ± SD	x_{min}*	x_{max}*
Energy	(MJ/d)	17.1 ± 3.0	11.6	22.0
	(kcal/d)	4087 ± 716	2776	5258
Protein	(g/d)	219 ± 85	129.1	371.1
	(%)**	22 ± 5	15	35
Carbohydrates	(g/d)	497 ± 138	374.4	612.7
	(%)**	49 ± 4	43	57
Fat	(g/d)	118 ± 51	62.9	168.9
	(%)**	26 ± 6	15	35
Alcohol	(g/d)	6.4 ± 17.4	0	24
	(%)**	0.7 ± 1.1	0	3.5
PUFA	(g/d)***	11.4 ± 7.7	4.4	16.3
Cholesterol	(mg/d)	534 ± 424	234.8	1077.3
Purine	(mg/d)	436 ± 289	184.9	811.1
Dietary Fiber	(g/d)	34.6 ± 16.3	21.0	53.3
Water	(l/d)	4.1 ± 1.6	2.6	5.9

* Minimal and maximal values of nutrient intake per person and day; ** expressed as % of total energy intake; *** polyunsaturated fatty acids

observed period of 2 weeks, administration of 3 to 14 (mean 7.8 ± 3.7) different supplement preparations per person were registered. While every subject consumed protein/amino acid containing and vitamin/mineral containing supplement preparations, carbohydrate supplementation was scarce (four persons).

"Breads and cereals" as well as "milk and dairy products" proved to be the most important food groups for the energy, protein, and carbohydrate intake of the bodybuilders (Fig. 2). Protein supply from the food groups "meat and meat products", "eggs and egg products", and "fish and fish products" together was not as high as that from "milk and dairy products" alone. Surprisingly, the food group "sugar and confectionaries" gave the second largest contribution to total fat and carbohydrate intake and amounted to 16 % of the total energy intake (Fig. 2).

Serum lipids

Mean concentrations of serum TG, PL, and CE as well as the fatty acid composition of these lipid fractions were listed in Table 4. For the group of bodybuilders an average serum TC concentration of 4.28 ± 1.06 mmol/l (control: 4.79 ± 0.79) was calculated. Two of the athletes showed TG and TC values above 1.7 mmol/l (150 mg/dl) and 5.2 mmol/l (200 mg/dl), respectively. Serum HDL-C concentration was 0.93 ± 0.33 mmol/l on the average; five subjects revealed HDL-C values below 0.9 mmol/l (35 mg/dl). In comparison to control subjects, the group of bodybuilders showed no statistically significant differences in the fatty acid composition of the PL fraction. However, in the TG fraction, significantly higher values for w-6 and w-3 PUFA (sums, 20:3 w-6, 20:4 w-6,

Table 3. Intake of selected minerals and vitamins as a total and by food of 13 German amateur bodybuilders

Nutrient		Total intake			Intake by food		
		Mean ± SD	% of DGE* recommendations		Mean ± SD	% of DGE* recommendations	
			a)	b)		a)	b)
Sodium	(g/d)	3.65 ± 0.98	[<2 g]		3.55 ± 1.00	[<2 g]	
Potassium	(g/d)	5.94 ± 1.65	[>2 g]		5.80 ± 1.62	[>2 g]	
Calcium	(mg/d)	2319 ± 896	232	149	2082 ± 759	208	134
Phosphorus	(mg/d)	3189 ± 1000	[1500 mg#]		3066 ± 915	[1500 mg#]	
Magnesium	(mg/d)	744 ± 232	213	136	687 ± 237	196	126
Iron	(mg/d)	26 ± 8	260	169	22 ± 5	220	143
Vitamin A‖	(mg/d)	1.1 ± 0.8	110	71	0.9 ± 0.7	90	58
Vitamin D	(μg/d)	3.0 ± 1.0	60		2.5 ± 1.1	50	
Vitamin E‖	(mg/d)	38.5 ± 33.6	321	205	13.3 ± 4.5	111	71
Vitamin B1	(mg/d)	12.3 ± 12.8		553	1.6 ± 0.6		72
Vitamin B2	(mg/d)	10.2 ± 8.5		398	3.3 ± 1.2		129
Vitamin B6	(mg/d)	55.3 ± 154.8		1263+ 1975^	2.9 ± 0.7		66+ 104^
Folate‖	(μg/d)	732.7 ± 552.7	488	306	235.7 ± 87.7	157	98
Niacin	(mg/d)	46.4 ± 23.0	258	170	24.4 ± 12.3	136	89
Vitamin C	(mg/d)	321.1 ± 233.3	428	268	140.1 ± 61.3	187	117

* DGE, 1991 (10); a) based on intake recommendations for 19–25 year old men with light activity; b) based on nutrient density recommendations for 19–25 year old men and an average energy intake of 17.1 MJ/d; # obligate and well tolerated intake; ‖ given as retinol equivalents, α-tocopherol equivalents or folate equivalents; + calculated on the basis of 0.02 mg Vitamin B_6/g protein and an average protein intake of 219 g/d; ^calculated on the basis of a maximal vitamin B_6 requirement of 2.8 mg/d.

Table 4. Concentration (mmol/l, Mean±SD) and fatty acid composition (mol-%, Mean±SD) of triglycerides, phospholipids, and cholesterol esters in the serum of 13 German amateur bodybuilders and controls (n=7)

	Triglycerides		Phospholipids		Cholesterol esters	
	Bodybuilders	Controls	Bodybuilders	Controls	Bodybuilders	Controls
Serum concentration	1.11 ± 0.50	1.05 ± 0.26	2.35 ± 0.47	2.71 ± 0.21	3.11 ± 0.84	3.45 ± 0.61
Fatty acid			(mmol/l)			
12:0	0.5 ± 0.4	0.2 ± 0.2	0.1 ± 0.1	0.0 ± 0.0	0.3 ± 0.2	0.3 ± 0.2
14:0	3.0 ± 1.5	3.7 ± 1.7	0.9 ± 0.2	0.6 ± 0.2	1.7 ± 0.5	1.6 ± 0.6
16:0	35.0 ± 5.6	36.4 ± 4.9	35.8 ± 2.9	35.8 ± 1.3	21.7 ± 2.7***	14.6 ± 3.2
16:1 w-7	2.9 ± 1.5**	5.0 ± 1.1	0.7 ± 0.5	0.9 ± 0.4	2.9 ± 1.0	3.3 ± 1.1
18:0	8.1 ± 1.7***	4.0 ± 1.6	13.6 ± 1.6	14.0 ± 1.2	4.2 ± 3.2**	1.4 ± 0.6
18:1 w-9	26.5 ± 5.6**	36.5 ± 6.0	11.5 ± 2.5	11.5 ± 2.0	19.6 ± 2.0	23.8 ± 6.4
18:2 w-6	16.7 ± 8.3	11.0 ± 4.1	22.4 ± 3.5	21.5 ± 1.9	41.6 ± 4.1***	50.9 ± 4.0
18:3 w-3	1.3 ± 0.9*	0.7 ± 0.1	0.5 ± 0.4	0.4 ± 0.1	0.8 ± 0.6	0.6 ± 0.2
20:0	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1
20:3 w-6	0.9 ± 0.6*	0.4 ± 0.3	3.1 ± 1.0	3.3 ± 0.5	1.1 ± 0.5	0.9 ± 0.4
20:3 w-9	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.3 ± 0.1	0.1 ± 0.1	0.1 ± 0.1
20:4 w-6	2.8 ± 1.8**	0.9 ± 0.3	7.3 ± 2.1	8.2 ± 1.4	4.3 ± 1.3	4.1 ± 1.2
20:5 w-3	0.4 ± 0.2	0.3 ± 0.1	0.8 ± 0.5	0.8 ± 0.1	0.6 ± 0.4	0.5 ± 0.2
22:0	0.2 ± 0.3	0.1 ± 0.1	0.1 ± 0.1	0.2 ± 0.2	0.1 ± 0.1	0.1 ± 0.2
22:4 w-6	0.4 ± 1.3	0.4 ± 0.1	0.7 ± 0.4	0.6 ± 0.2	0.8 ± 0.5***	0.0 ± 0.0
22:6 w-3	1.2 ± 0.8**	0.5 ± 0.2	2.3 ± 0.7	2.3 ± 0.5	0.8 ± 0.4	0.4 ± 0.2
Σ SFA#	46.9 ± 6.1	44.4 ± 7.5	50.6 ± 3.6	50.8 ± 1.8	28.1 ± 5.2***	18.2 ± 3.5
Σ MUFA$	29.4 ± 6.5***	41.5 ± 6.0	12.8 ± 4.2	12.4 ± 2.2	22.5 ± 2.5	27.1 ± 6.0
Σ PUFA ŵ-6	20.8 ± 9.0*	12.6 ± 4.4	33.5 ± 4.2	33.5 ± 1.9	47.7 ± 5.1***	56.0 ± 3.7
w-3	2.7 ± 1.2***	1.5 ± 0.3	3.5 ± 0.9	3.5 ± 0.6	2.2 ± 0.9	1.6 ± 0.5

Saturated fatty acids; $ monounsaturated fatty acids; ˆ polyunsaturated fatty acids; * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$ (unpaired t-test)

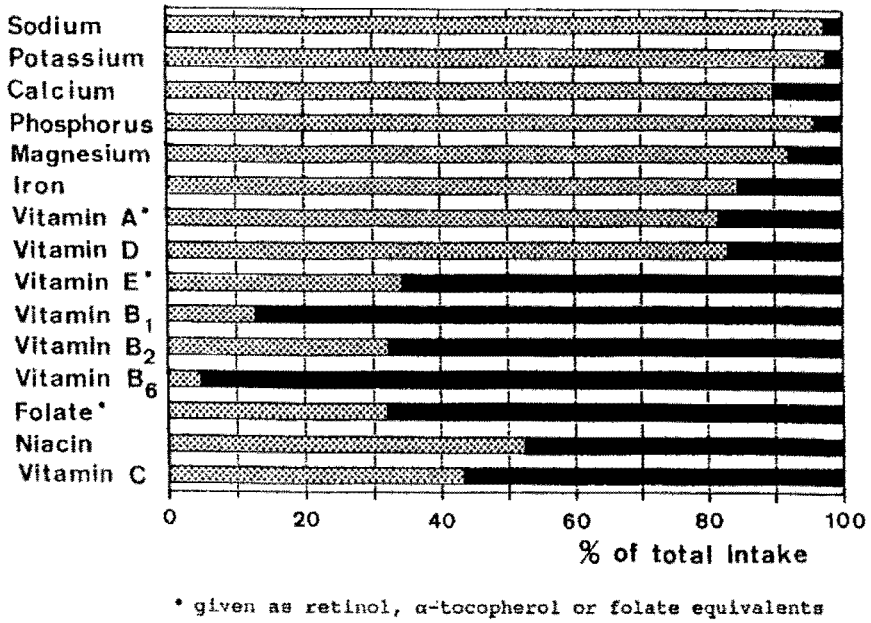

Fig. 1. Mean contribution of diet (●) and supplements (■) to the average daily intake of selected minerals and vitamins in 13 German amateur bodybuilders

18:3 w-3, 22:6 w-3) as well as lower values for monounsaturated fatty acids (MUFA; 16:1 w-7, 18:1 w-9) were obtained; concomittantly, the concentration of stearic acid (18:0) was elevated. On the other hand, in the CE fraction, the amount of linoleic acid (18:2 w-6), and consequently the sum of w-6 PUFA, was significantly lower in the group of bodybuilders, while the saturated fatty acids (16:0, 18:0) were higher than in the controls.

Discussion

Dietary intake

Considering a constant mean body weight during the 2 weeks of investigation, an average energy intake of 17.1 MJ/d was assumed to be adequate to reach energy balance. Besides their weight training program, 11 bodybuilders were involved in other sports activities (e.g. playing tennis, jogging, riding a bicycle) which further increased the energy requirements of the athletes. This may also be an explanation for the slightly lower mean energy intake data of 14.8 to 16.6 MJ/d found in other studies with bodybuilders (7, 12, 13, 18, 34).

The contribution of fat to total energy intake was at the lowest limit of the recommended range of 25–30 % (10) and therefore differed distinctly from the generally practiced high fat intake in industrialized countries (26). In comparison to the results of other studies with bodybuilders (mean range of 168 – 214 g/d) (7, 12, 28, 34) the average amount of 118 g fat per day in this study was low. About 50 % of dietary fat was derived directly from animal products (Fig. 2), while another 34 % was supplied by the food groups "breads and cereals" and "sugar and confectionaries" together. Thus, PUFA intake with an average of 2.5 energy-% did not reach the recommendations of DGE (3.5 energy-%, 10). In the literature, up to three times higher PUFA intake values were reported (13, 28). For the wide range of interindividual variability in PUFA intake with

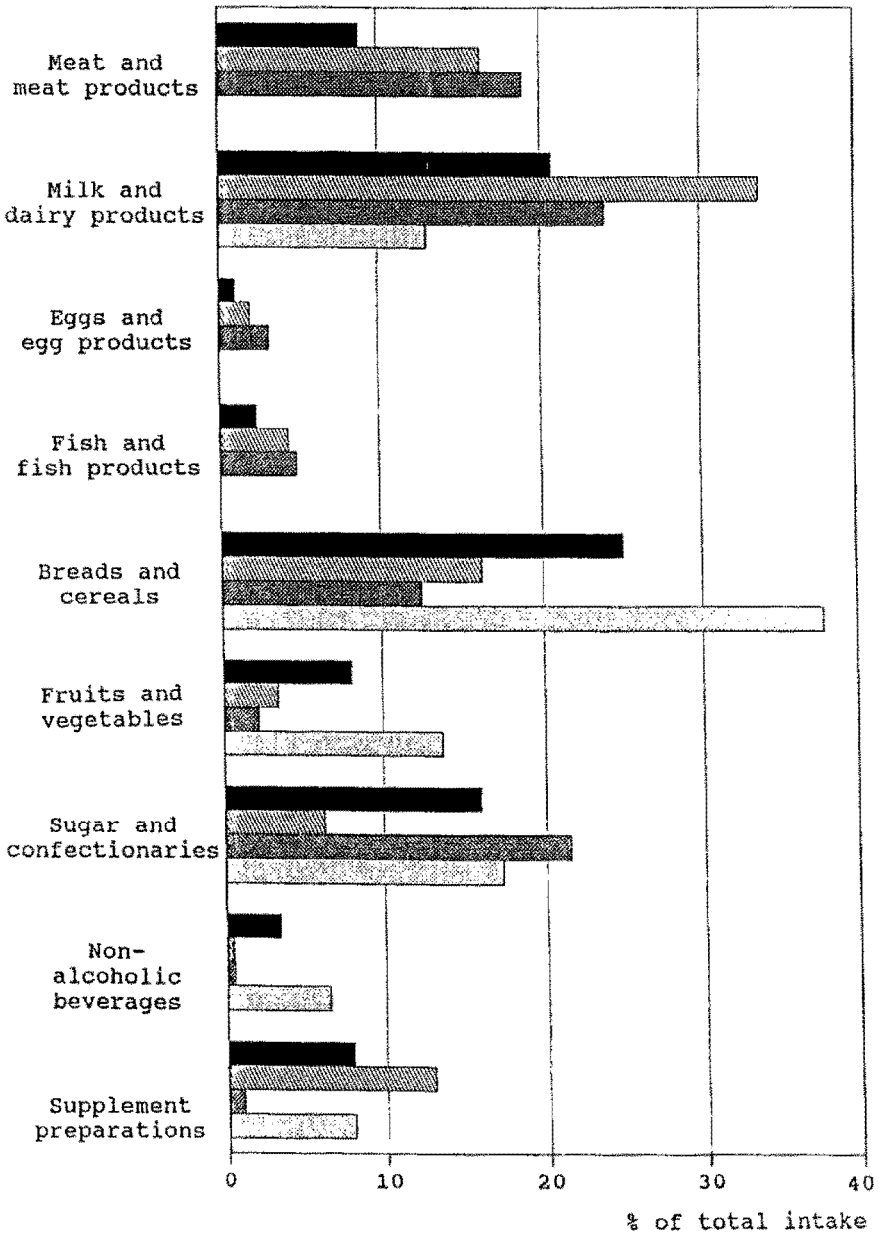

Fig. 2. Mean contribution of different food groups and supplements to the average daily intake of energy (■), protein (▒), fat (▓), and carbohydrates (□) in 13 German amateur bodybuilders

values down to 4.4 g/d as well as a probably even lower fat intake during precontest periods (21, 37), fatty acid profiles of different serum lipid fractions were determined (see below).

Generally, many strength athletes are convinced that a very high protein intake is necessary to promote and maintain muscle mass. However, the protein requirement in physical exercise is under discussion (11, 29) and negative long-term effects of high protein intake on health still have to be clarified (11). Experimental evidence is lacking that protein consumption beyond a value of 2 g*kg bw^{-1}*d^{-1} is effective in the development of muscle mass and strength (11, 29). In bodybuilders protein requirement has been shown to be 1.12 times higher than in sedentary controls (38). According to national

expert committees, protein intake should not amount to more than twice the recommendation (10, 31), which corresponds to 143 g/d for an average body weight of 89.3 kg. All but one participant in the present study exceeded this recommendation. Mean protein intake of the bodybuilders was found to be 2.45 ± 0.95 g*kg $bw^{-1}*d^{-1}$; the same value was reported by Faber and coworkers (12, 13) for a group of South African bodybuilders, while in most other studies slightly lower results were obtained (7, 8, 34). Surprisingly, protein intake from supplement preparations was rather low (Fig. 1) and agreed with reference results (7, 8, 12).

Because of the lack of experimental data, satisfactory and uniform micronutrient intake recommendations for strength athletes are not available so far (for review, see (19)). Therefore, in the literature dealing with recommendations on the mineral and vitamin intake of athletes, a very high disparity can be found. To avoid a detailed discussion of this issue which is not pertinent to this paper, comparisons of intake data were made with both the recommendations of DGE (10) a) for 19– <25 year old men with light activity as well as b) for nutrient density in the case of those nutrients, for which higher requirements in athletes are discussed (Table 3). For vitamins, whose requirement is known to be dependent on energy intake only b) is calculated, and for vitamin B_6 intake recommendations the protein consumption was considered.

Except for the vitamins A and D, the average amounts of total intake of the recorded minerals and vitamins met the recommendations of DGE (10) or exceeded them (Table 3). While the vitamin B_6 and phosphorus intake of some bodybuilders may implicate risks for health, the high supply of some water soluble vitamins seems harmless (1, 10). On the other hand, there is still no evidence available that any beneficial effect on muscle performance or formation could be expected with vitamin doses far beyond the actual requirements (2, 19). With exception of a much higher intake of the vitamins B_1, B_6 and folate, the results were in accordance to those obtained in a group of German strength athletes (7). In other investigations mostly higher values for mineral and vitamin intake of bodybuilders were found, but not for vitamin B_6 (13, 28).

As shown in Table 3, the intake of the investigated minerals by foodstuff alone was sufficient to fullfill the recommendations. Therefore, supplementation with mineral pills was not necessary, even in the case of iron, for which the athletes' requirement seems to be higher (2, 39). Actually, the contribution of supplement preparations to the total intake of minerals in this group of bodybuilders was small (Fig. 1) and agrees with reference results (7). Concerning vitamins, supplementation of the diet seems to have been meaningful for the vitamins A, D, E, B_1 and probably B_6 (< 3/4 of the recommendation; Table 3). However, with the shown supplementation practice of the bodybuilders a very high total intake of most vitamins could be observed. In particular, the enormously high intake of the vitamin B_6 by means of supplement preparations resulted in a total intake of 1263 % or 1975 % of the recommended amount (Table 3). Compared to the results gathered in a group of German strength athletes, a much higher contribution of supplements to the total intake of the B-vitamins – specifically vitamin B_6 – was found for the bodybuilders (7). Generally, nutrient supplements seem to contain – if at all – only small amounts of the vitamins A and D (8). Thus, the intake of these two vitamins was hardly increased by the shown supplementation practice.

Regarding the high energy intake of the bodybuilders, with selection of a mixed food diet micronutrient intake recommendations should be easily met. For the investigated group of bodybuilders, replacement of products from the food group "sugar and confectionaries" with food of higher nutrient density would increase nutrient intake data by

food alone and make the recommendations fulfilled without using any dietary supplement (Table 3).

Cholesterol intake of the bodybuilders was comparable to the average German intake of age-matched males (9) and in contrast to the high cholesterol intake of other bodybuilders with up to 1.44 g/d (13, 28). Total purine intake was markedly low; this should be due to the diet containing high amounts of milk and dairy products and less meat/meat products (Fig. 2).

Serum lipids

In contrast to aerobic exercise (17, 20), with anaerobic exercise (e.g., anabolic steroid-free weight lifters and bodybuilders) no (14, 28) or even negative effects on serum HDL-C levels (3, 40) were reported. The use of anabolic steroids, which seems to be widespread in strength athletes, can lead to a further decrease of HDL-C concentrations (25, 28, 41). In five bodybuilders of this study, reduced levels of HDL-C (< 0.9 mmol/l) were found. In spite of missing systematic differences between self-declared anabolic steroid users and non-users, one of the steroid users showed the extreme values of 6.97 mmol/l total cholesterol and 0.18 mmol/l HDL-C in the serum. This result can be seen as a further fact against the use of anabolic steroids in sports.

Average TG and TC levels were in a normal range as found in other studies (3, 14, 28).

In the fatty acids of the PL fraction, the differences between the group of bodybuilders and the control subjects were minimal and of no statistical significance; in particular, the sums of different fatty acid classes revealed nearly identical means for both groups (Table 4). The composition of PL fatty acids lay within the reported range of "normal" variability (6, 23, 24). In contrast to PL, the fatty acid profile of TG reflects the composition of the dietary fat of the last few meals; that of CE is a valid index of the dietary fat intake of the preceding weeks (16). In comparison to the control group, the fatty acid composition of the CE fraction indicates a bodybuilders' diet higher in saturated fatty acids (16:0, 18:0) and lower in polyunsaturated fatty acids (18:2 w-6) during the last weeks prior to blood sampling. Regarding what literature describes as a "normal" range (6, 16, 23), the bodybuilders revealed palmitic acid (16:0) and stearic acid (18:0) concentrations in the CE fraction at the upper limit, whereas linoleic acid (18:2, w-6) concentrations were found to be at the lowest limit. These findings confirm the results of the dietary assessment.

In conclusion, the present study shows that the bodybuilders' nutrient intake by means of ordinary foodstuffs alone was largely favorable compared to the recommendations of DGE. A few corrections in food selection patterns – particularly limiting intake of the food group "sugar and confectionaries" – can lead to a well-balanced nutrient supply and makes the supplementation with pills and powders unnecessary. In the case of protein, the average intake by food alone (2.13 $g^{*}kg\ bw^{-1*}d^{-1}$) lay already above the recommended amounts.

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