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Dietary Protein Intake and Distribution Patterns of Well-Trained Dutch Athletes

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Dietary protein intake should be optimized in all athletes to ensure proper recovery and enhance the skeletal muscle adaptive response to exercise training. In addition to total protein intake, the use of specific protein-containing food sources and the distribution of protein throughout the day are relevant for optimizing protein intake in athletes. In the present study, we examined the daily intake and distribution of various protein-containing food sources in a large cohort of strength, endurance and team-sport athletes. Well-trained male (n=327) and female (n=226) athletes completed multiple web-based 24-hr dietary recalls over a 2-4 wk period. Total energy intake, the contribution of animal- and plant-based proteins to daily protein intake, and protein intake at six eating moments were determined. Daily protein intake averaged 108±33 and 90±24 g in men and women, respectively, which corresponded to relative intakes of 1.5±0.4 and 1.4±0.4 g/kg. Dietary protein intake was correlated with total energy intake in strength (r=0.71, p <.001), endurance (r=0.79, p <.001) and team-sport (r=0.77, p <.001) athletes. Animal and plant-based sources of protein intake was 57% and 43%, respectively. The distribution of protein intake was 19% (19±8 g) at breakfast, 24% (25±13 g) at lunch and 38% (38±15 g) at dinner. Protein intake was below the recommended 20 g for 58% of athletes at breakfast, 36% at lunch and 8% at dinner. In summary, this survey of athletes revealed they habitually consume > 1.2 g protein/kg/d, but the distribution throughout the day may be suboptimal to maximize the skeletal muscle adaptive response to training.

Keywords: exercise training, protein distribution, plant-based proteins

Ingestion of adequate dietary protein is a fundamental consideration to ensure proper recovery from the physiological stress of prolonged exercise training. Dietary protein promotes resistance training-induced gains in muscle mass and strength (Cermak et al., 2012; Morton et al., 2015). Although less recognized, dietary protein supplementation may also facilitate optimal recovery from strenuous endurance-type exercise training and support skeletal muscle repair and remodeling (Koopman et al., 2004; Moore et al., 2014). Consequently, protein intake should be optimized in all athletes to enhance the skeletal muscle adaptive response to exercise training, improve muscle recovery, increase exercise training efficiency and, as such, maximize performance capacity.

The current recommended daily allowance (RDA) for protein is 0.8 g/kg/d (Institute of Medicine, 2005). This amount is deemed sufficient for everyone, including athletes (Institute of Medicine, 2005), but it has been proposed that athletes involved in strenuous exercise training require more dietary protein than their sedentary counterparts (Tarnopolsky, 2004; Phillips et al., 2007). Dietary protein intake recommendations for athletes has been up to two fold higher than the RDA, with suggestions of 1.2 - 1.6 (Phillips et al., 2007), 1.2 - 1.7 (Rodriguez et al., 2009) and most recently, 1.3 -1.8 g/kg/d (Phillips & Van Loon, 2011). The protein content of a healthy diet typically ranges between 15-25 EN% however (Fulgoni, 2008), suggesting that protein intake is strongly determined by total energy intake. Given the greater energy expenditure and energy intake in athletes (Saris et al., 1989), it seems obvious that dietary protein consumption is well above the recommended guidelines.

A number of food sources contribute to daily protein intake, all of which differ in amino acid composition and rates of digestion and absorption (Van Vliet et al., 2015). Though animal based proteins are considered to have greater anabolic properties than plant-based proteins

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(Hartman et al., 2007; Tang et al., 2009), a substantial part of daily protein intake is derived from plant-based food sources (Van Vliet et al., 2015). There are currently no data quantifying the contribution of different food sources to total protein intake in athletes. Based upon the proposed greater protein consumption in active athletes, we questioned what specific food sources contribute to the daily protein intake in various athlete groups.

Further to protein quantity and quality, the daily distribution of ingested protein influences the extent of physiological remodeling. A single 20-25 g bolus of high quality protein maximally stimulates rates of muscle protein synthesis (Cuthbertson et al., 2005; Moore et al., 2009; Witard et al., 2014). For this reason, consuming 4-5 evenly spaced feedings containing 20 g of high quality protein throughout the day is considered optimal for maximizing muscle protein synthesis (Phillips & Van Loon, 2011; Areta et al., 2013; Mamerow et al., 2014). Findings from Erdman et al. (2013) indicate that male and female elite athletes consume only three daily meals containing ≥ 20 g of protein, with the highest quantities skewed towards the evening meal. To gain further insight into protein intake distribution, we sought to characterize the daily consumption patterns of various protein-containing food sources in a large cohort of well-trained athletes.

Information on the quantity and timing of specific dietary protein sources among athletes would yield valuable insight into patterns of protein consumption and may serve to encourage recommendations beyond total daily protein intake. However, data characterizing the consumption patterns of specific protein containing food sources in athletes are limited. Therefore, the aim of the present work was to comprehensively examine the daily intake and distribution of various protein containing food sources in a large cohort of well-trained athletes. We hypothesized that habitual protein intake is closely related to daily energy intake, resulting in protein consumption well above the recommended guidelines. We further hypothesized that plant-based proteins represent a substantial component of daily protein intake, and that the daily distribution of dietary protein intake is suboptimal in athletes.

Methods

Subjects and Ethics Approval

A total of 553 Dutch elite athletes took part in the study (Table 1). Participants were between 12 and 62 years and performed more than 9 hours of exercise per week. All athletes had either, 1) held an elite athlete status of the Dutch Olympic Committee (NOC*NSF); 2) participated in a European or World Championship; or 3) proved to be top level in their discipline on a national level. Based on their particular discipline, participants were classified into one of three sport categories: 1) endurance; 2) team-sports; or 3) strength and/or sprint sports. A detailed breakdown of all disciplines within each sport category is provided (Supplemental Table 1). All participants provided written informed consent. The survey was conducted according to the Declaration of Helsinki and was approved by the Medical Ethics Committee of Wageningen University.

Experimental Protocol

Data were collected as part of the Dutch Sport Nutrition and Supplement Study (DSSS) that was performed between February 2012 and June 2015. Following inclusion, participants were asked to complete three unannounced web-based 24-hr dietary recalls and dietary supplement questionnaires during the conditioning phase of their training program. Data collection days were scheduled over a 2- to 4-week period and were at least 4 days apart. Collection days were selected to include two weekdays and one weekend for each participant. If the 24-hr recall and questionnaires were not completed within 36 hours, collection was rescheduled. Overall, athletes were given a maximum of four opportunities to deliver three 24-hr recalls and questionnaires.

24-hr Dietary Recalls

The 24-hr recalls were collected using 'Compl-eatTM', a web-based program that guides participants to accurately report food and drinks consumed the previous day. Compl-eatTM is based on the five-step multiple-pass method, a validated technique to increase accuracy of 24-h dietary recalls (Conway et al., 2003). The program included a wide selection of foods commonly consumed in a Dutch food pattern (Stichting NEVO, 2010), but did not include dietary supplements or sport nutrition products. Protein intakes using this dietary recall method have been validated against nitrogen excretions (Wardenaar et al., 2015), however comparisons to weighed food records have not been made. Details regarding participant data entry into Compl-eatTM is reported elsewhere (Wardenaar et al., 2015). Trained dietitians assessed all dietary recalls for completeness, unusual portion sizes, and possible missing food groups often consumed at main meals. Where appropriate, the participants were asked for further information.

Questionnaires

Web-based questionnaires regarding training load (minutes of exercise per day) and use of nutritional supplements were collected on three occasions in conjunction with the 24-h dietary recalls. Questionnaires were collected using the 'vitality portal' as reported elsewhere (Wardenaar et al., 2015). Briefly, participants were asked to specify any nutritional supplements consumed. A list of over 3400 products from the Dutch Database for Dietary Supplements (NES) was provided to aid the participants (RIVM, 2015). If a product consumed was not on the list, researchers obtained information from the nutritional label provided by the manufacturers.

Determination of Protein Intake from 24-hr Dietary Recalls

For each collection day, dietary energy (MJ) and protein (g, g/kg, %En) intake were determined using the Dutch

Table 1 Subject Characteristics

Characteristics	Male Athletes				Female Athletes			
	Total	Strength	Team Sports	Endurance	All	Strength	Team Sports	Endurance
	(*n*=327)	(*n*=32)	(*n*=138)	(*n*=157)	(*n*=226)	(*n*=39)	(*n*=104)	(*n*=83)
Age	23 ± 12	21 ± 5	18 ± 5	29 ± 14	22 ± 8	21 ± 7	21 ± 5	24 ± 10
Weight (kg)	72 ± 14	82 ± 9	67 ± 15	75 ± 11	65 ± 9	61 ± 11	67 ± 8	63 ± 8
Height (cm)	181 ± 11	183 ± 6	176 ± 12	184 ± 8	172 ± 8	166 ± 9	174 ± 8	173 ± 8
BMI (kg/m2)	22 ± 3	25 ± 3	21 ± 3	22 ± 2	22 ± 2	22 ± 2	22 ± 2	21 ± 2
Energy intake (mJ/d)	11.5 ± 3.2	11.6 ± 2.7	10.5 ± 2.5	12.3 ± 3.6	9.0 ± 2.4	8.5 ± 2.2	8.2 ± 1.6	10.2 ± 2.8
Protein intake (g/d)	108 ± 33	123 ± 36	101 ± 29	112 ± 35	90 ± 24	89 ± 28	86 ± 21	95 ± 26
Protein intake (en%)	16 ± 3	18 ± 3	16 ± 3	16 ± 3	17 ± 3	18 ± 4	18 ± 3	16 ± 3
Protein intake (g/kg/d)	1.5 ± 0.4	1.5 ± 0.4	1.5 ± 0.4	1.5 ± 0.4	1.4 ± 0.4	1.5 ± 0.5	1.3 ± 0.3	1.5 ± 0.4
Plant protein (g)	46 ± 16	50 ± 14	38 ± 10	53 ± 18	38 ± 14	32 ± 11	33 ± 10	46 ± 15
Plant protein (%)	44 ± 11	42 ± 12	40 ± 10	48 ± 11	43 ± 13	37 ± 12	40 ± 11	49 ± 13
Animal protein (g)	62 ± 25	73 ± 30	63 ± 25	59 ± 24	52 ± 20	57 ± 26	53 ± 19	49 ± 19
Animal protein (%)	56 ± 11	58 ± 12	60 ± 11	52 ± 11	57 ± 13	63 ± 12	60 ± 11	51 ± 13

Food Composition Database (Stichting NEVO, 2010). The contribution of animal and plant-based sources to dietary protein intake (g) were determined and expressed as a percentage of total protein intake. Daily protein intake was categorized into six eating moments: breakfast, morning snack, lunch, afternoon snack, dinner and evening snack. An average of all collection days was determined for each participant.

Determination of Protein Supplementation Among Athletes

Protein intake (g) from nutritional supplement questionnaires was determined for each participant. "Protein supplement-users" were defined as athletes consuming ≥ 10 g of protein/d from supplements. The contribution of dietary protein (g/d, g/kg/d) and supplemental protein (g/d, g/kg/d) was calculated for "supplement-users". Dietary protein intake (g/d, g/kg/d) was calculated for "non-supplement users".

Statistical Analysis

Data analyses were performed using SPSS Statistics (version 21). Data are presented as mean ± standard deviation or as a percentage. Pearson's product-moment correlation coefficient was used to calculate the relationship between daily energy and protein intake.

Results

Athletes' Characteristics

A total of 553 athletes (*n*=327 male; *n*=226 female) were classified as strength (*n*=71, team-sports (*n*=242) or endurance (*n*=240) athletes. Descriptive characteristics are presented in **Table 1**. Detailed information on the specific sport disciplines within each category, and corresponding descriptive characteristics, are presented in **Supplemental Table 1**.

Dietary Protein Intake

Daily protein intake data for the individual sport categories are presented in **Table 1**. Average energy intake was 11.5±3.2 MJ/d in males and 9.0±2.4 MJ/d in females. Daily protein intake was 108±33 g (1.5±0.4 g/kg) in males and 90±24 g (1.4±0.4 g/kg) in females, representing 16±3 and 17±3% of energy intake (EN%), respectively. Protein intake was well above the recommended 1.2 g/kg/d in 73% of athletes, and ranged from 0.5 to 2.7 and 0.4 to 3.6 g/kg/d in the male and female athletes, respectively. Dietary protein intake strongly correlated with daily energy intake in strength ($r = 0{,}71$; $p < .001$), team sports ($r = 0.77$; $p < .001$), and endurance ($r = 0.79$; $p < .001$) athletes (**Figure 1**).

Dietary Protein Sources

Plant and animal-based protein sources contributed 43 and 57% of total protein intake, respectively (**Table 1**). The contribution of various plant and animal-based protein food sources is depicted in **Figure 2.** Meat, meat products and poultry were the most dominant protein-containing food source, representing 32% of total protein intake. Bread was the most prevalent plant-based protein source, contributing 19% of total protein intake **(Figure 2)**. Plant-based protein sources contributed 50% of protein intake at breakfast (10±5 g) and lunch (12±7 g) and 29% at dinner (11±5 g). Thus, animal-based protein

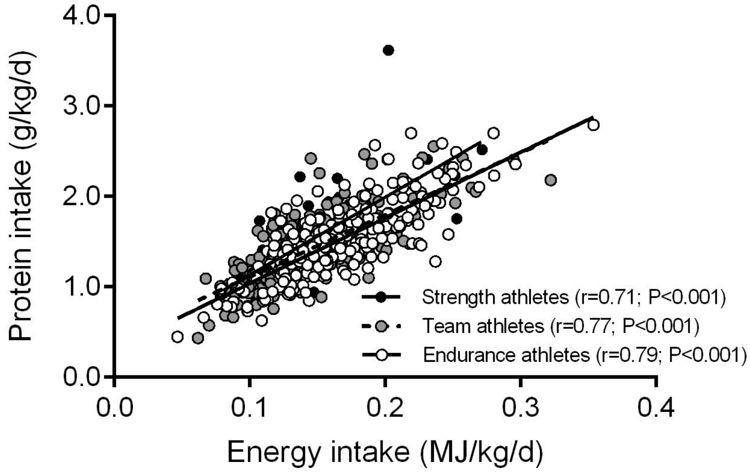

Figure 1 — Relationship between dietary energy intake and total protein intake in strength, team-sport, and endurance athletes.

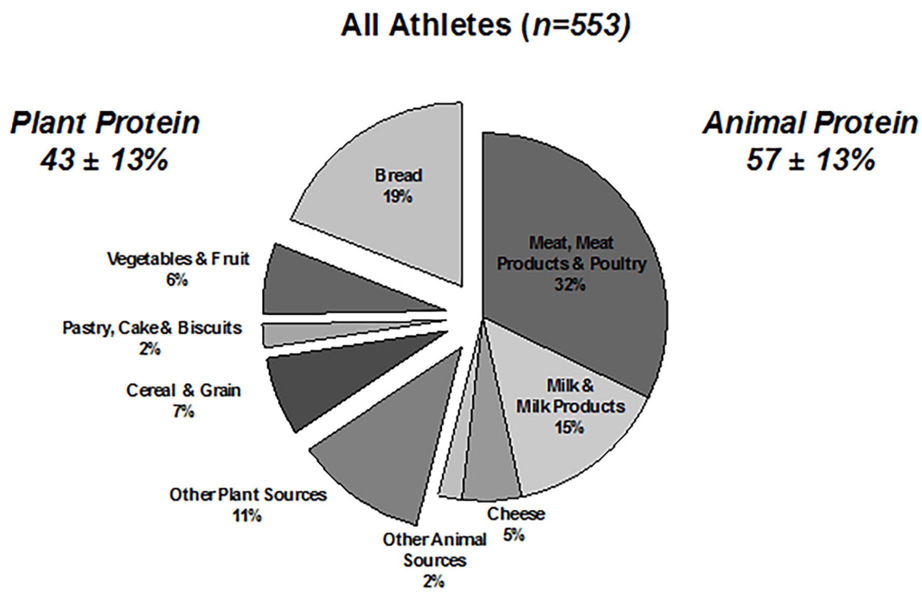

Figure 2 — Contribution of plant and animal food sources to total daily protein intake in athletes.

sources contributed 50% of protein intake at breakfast (9±5 g) and lunch (13±10 g), and 71% at dinner (26±14 g) (**Figure 3**).

Dietary Protein Intake Distribution

Protein intake at breakfast (19±8 g), lunch (25±13 g) and dinner (38±15 g) contributed 81% of total protein intake (**Figure 3**). Protein intake at the main meals was below the recommended 20 g per serving in 58% of the athletes at breakfast, 36% at lunch, and 8% at dinner.

Protein Supplementation

Protein supplements were used among 16% of the strength athletes, 7% of the team sports athletes and 11% of the endurance type athletes (**Figure 4; Supplemental Table 2**). Among all athlete groups, average dietary protein intake was 98±29 g (1.5±0.4 g/kg/d) in non-supplement users and 130±42 g (1.7±0.5 g/kg/d) in supplement users. Supplemental protein provided 22±11 g (0.3±0.2 g/kg/d), resulting in a total protein intake of 152±44 g (2.0±0.5 g/kg/d) among supplement-users (**Figure 4**).

Discussion

The present study shows that daily protein intake is closely related to total energy intake in well-trained athletes. Athletes typically consumed well above the recommended 1.2 g of protein/kg/d from their habitual diet, which was largely attributed to the relatively high

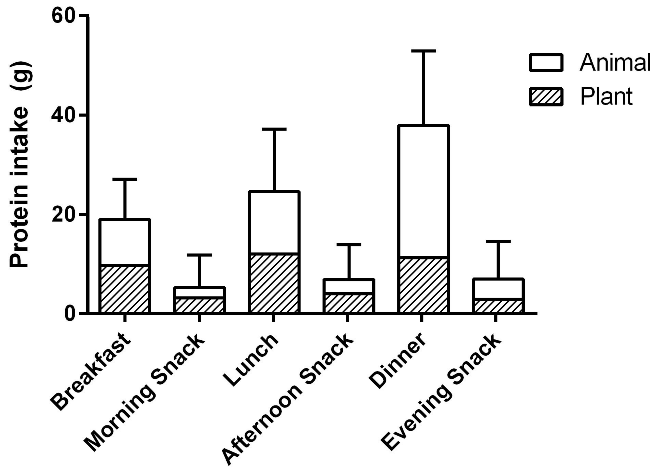

Figure 3 — Distribution and sources of dietary protein intake throughout the day among athletes

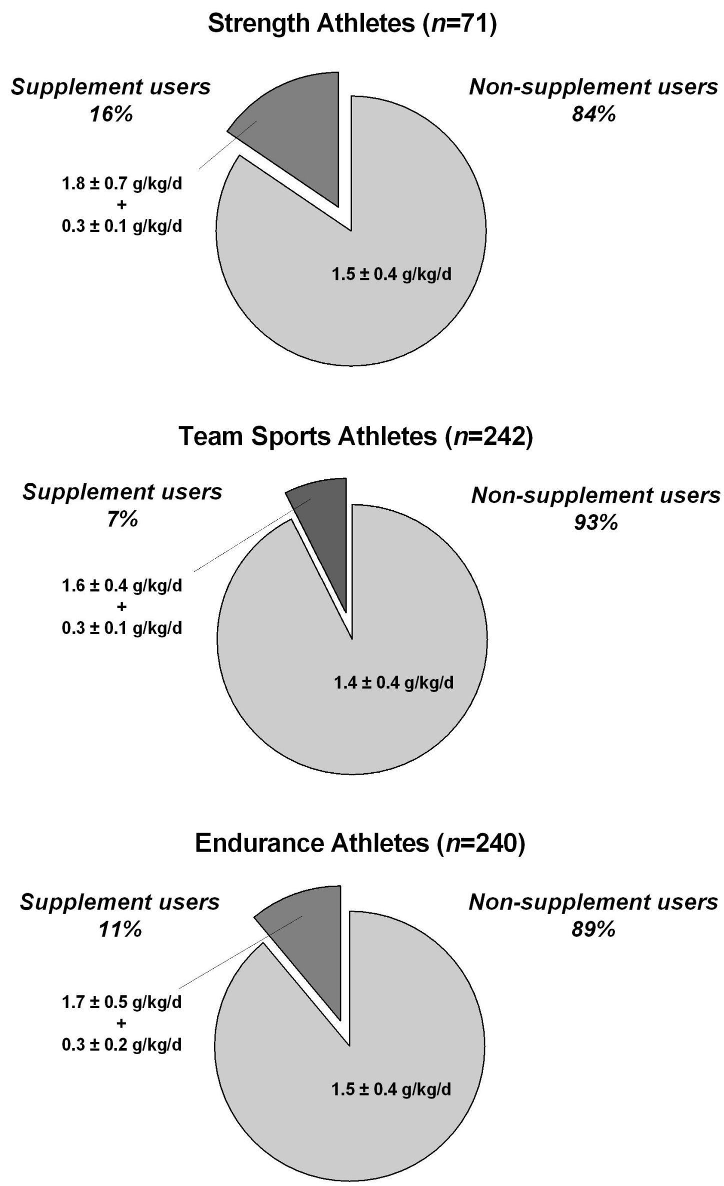

Figure 4 — Prevalence of protein supplementation among strength (**A**), team-sport (**B**) and endurance (**C**) type athletes. Contribution of dietary, or dietary + supplemental protein (g/kg/d), is depicted for all athletes' groups.

daily energy intake. While the majority of protein consumed originated from animal-based food sources, plant-based proteins contributed more than 40% of daily dietary protein intake. More than 80% of daily protein consumption was distributed over the three main meals, with the largest intake at dinner (~38 g). These findings are the first to characterize the quantity and distribution of specific protein-containing food sources in a large cohort of well-trained athletes, providing valuable information for optimizing patterns of protein intake in athletes.

Consumption of adequate dietary protein is a fundamental component of proper recovery from the physiological stress of prolonged exercise training. While it was originally proposed that the recommended daily allowance of 0.8 g/kg/d was sufficient for everyone, including athletes (Institute of Medicine, 2005), it is now believed that athletes involved in strenuous exercise require a greater daily protein intake (Tarnopolsky, 2004; Phillips et al., 2007). (Tarnopolsky, 2004; Phillips et al., 2007). As such, protein intake recommendations for athletes have focused on the quantity of daily protein, with guidelines increasing from 1.2 – 1.6 (Phillips et al., 2007), 1.2 – 1.7 (Rodriguez et al., 2009) and most recently, 1.3 – 1.8 g/kg/d (Phillips & Van Loon, 2011). It is well established that the protein content of a healthy diet typically ranges between 15-25 EN% (Fulgoni, 2008), implying that dietary protein intake is strongly determined by total energy intake. Indeed, in the present study we observed a strong positive correlation between habitual protein consumption and total energy intake (Figure 1). Given the relatively high daily energy intake in both the male and female athletes, habitual protein intakes averaged ~1.5 g/kg/d, representing 17% of daily energy intake. Consequently, dietary protein consumption was well above the suggested lower limit of 1.2 g/kg/d in all athletes, regardless of supplemental protein use. These findings show that dietary protein intake in athletes is largely determined by total energy intake, resulting in a level of daily protein intake well within the recommended guidelines. Thus, it may be more strategic for protein recommendations to move beyond total intake, and focus more on other factors known to modulate the efficacy of dietary protein to support skeletal muscle repair and remodeling.

The specific food sources contributing to dietary protein intake may be an important consideration for optimizing protein consumption in athletes. Daily protein intake is derived from a number of protein-containing food sources, however information on the specific food sources that contribute to total protein intake in athletes is scarce. Plant-based proteins are considered to have lower anabolic properties than animal-based proteins (Hartman et al., 2007; Tang et al., 2009), however plant-based food sources contribute substantially to the protein intake of a traditional diet (Van Vliet et al., 2015). Indeed, our findings revealed that more than 40% of daily dietary protein intake originates from plant-based sources in well-trained athletes, with bread as the dominant food source (Figure 2). The contribution of plant-based protein sources to protein intake was greater at breakfast and lunch (50%), and less prevalent at dinner when >70% of protein originated from animal-based food sources. These data are the first to show that plant-based proteins represent a substantial proportion of total daily protein intake in well-trained athletes.

Various strategies have been proposed to augment the anabolic properties of plant-based proteins, including fortification with essential amino acids or the blending of various plant protein sources, with or without animal protein, to improve amino acid composition (Van Vliet et al., 2015). In the present study, all meals contained a blend of various plant- and animal-based protein sources, which may limit the proposed relative deficiency of essential amino acids in various plant-based proteins. Given the substantial contribution of plant-based food sources to total protein intake, it seems imperative that guidelines for optimizing protein intake in athletes incorporate strategies to augment the anabolic properties of mixed meals.

The distribution of dietary protein intake throughout the day also represents an important consideration for optimizing protein intake in athletes. In the present study, more than 80% of protein intake was distributed over breakfast (~19 g), lunch (~25 g) and dinner (~38 g), revealing a skewed pattern of protein intake towards the evening meal (Figure 3). It has been demonstrated that post-prandial muscle protein synthesis rates are maximized following ingestion of a 20-25 g bolus of high quality protein (Cuthbertson et al., 2005; Moore et al., 2009; Witard et al., 2014). For this reason, consuming a balanced distribution of protein throughout the day, consisting of 4-5 evenly spaced feedings of 20 g high quality protein, has been suggested to be optimal for maximizing post-prandial muscle protein synthesis rates (Phillips & Van Loon, 2011; Areta et al., 2013; Mamerow et al., 2014). Though total protein intake of our athletes (~1.5 g/kg/d) were well within the recommended guidelines, meals containing 20 g protein or more were only consumed three times per day. Closer evaluation revealed that protein intake was below 20 g in 58% of athletes at breakfast and 36% at lunch, despite group averages at or above the 20 g protein minimum. Our findings highlight that many athletes may have suboptimal practices when it comes to protein intake distribution throughout the day.

A potentially important and perhaps overlooked opportunity to consume a high-protein meal is before going to bed. We have previously shown that protein ingested prior to (Res et al., 2012) or during (Groen et al., 2012) sleep is properly digested and absorbed, increasing amino acid availability and augmenting overnight muscle protein synthesis rates. When evaluated over the long-term, ingestion of a protein supplement prior to sleep was shown to augment gains in muscle mass and strength gains during a 12-week resistance-type exercise training program in young men (Snijders et al., 2015). Consistent with previous reports (Erdman et al., 2013), athletes in the present study only consumed ~7 g of protein as part of their evening snack. Promoting a more balanced distribution of dietary protein intake throughout the day, including a protein-rich pre-sleep snack, may represent an effective dietary strategy to improve post-exercise muscle recovery and optimize skeletal muscle reconditioning in athletes.

To conclude, daily protein intake is strongly determined by total energy intake in well-trained athletes. Given the higher energy intake among active athletes, protein consumption from dietary sources exceeds well beyond the recommended 1.2 g/kg/d. Protein supplementation is not required for athletes to meet the current recommendations for daily protein intake. Though most protein consumed is of animal origin, plant-based food sources contribute more than 40% of daily protein consumption. The three main meals provide the majority (80%) of protein intake, with the highest quantities consumed at dinner (~38 g). Though athletes generally consume ample protein, distribution of daily protein intake remains far from what is believed to be optimal to support skeletal muscle reconditioning. Recommendations for protein intake in athletes should move beyond total protein intake and focus more on optimizing protein quality and protein intake distribution to support the skeletal muscle adaptive response to prolonged exercise training.

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Supplemental Table 1 Group Characteristics for Type of Exercise, Sport, Gender, and Level of Exercise

Exercise Type	Men						Women					
	n	Height	Weight	BMI	Age	Exercise	*n*	Height	Weight	BMI	Age	Exercise
Endurance	**157**	**184.2±7.5**	**75.1±10.8**	**22.0±2.1**	**29.1±13.7**	**92.5±52.5**	**83**	**173.3±7.6**	**63.3±8.4**	**21.0±2.1**	**23.9±10.1**	**104.3±59.0**
Rowing[a,c,d]	34	191.5±6.5	85.1±10.3	23.1±1.8	21.6±2.2	88.9±34.7	26	178.7±7.1	70.8±5.9	22.2±1.4	21.8±2.4	107.2±55.7
Swimming[a,b]	11	188.0±7.0	82.1±8.4	23.2±1.8	20.1±4.8	88.0±35.6	9	174.6±7.5	63.8±5.5	20.9±1.0	16.9±1.7	105.4±37.1
Ice skating[b,c]	15	181.8±5.6	72.0±6.6	21.7±1.2	18.8±1.9	97.4±85.1	11	171.4±4.4	60.8±5.8	20.7±1.5	17.3±2.4	97.5±68.4
Road cycling[b,c]	34	180.4±7.1	66.1±7.3	20.3±1.7	18.3±4.4	105.9±57.0	14	172.3±6.3	63.4±5.9	21.4±1.9	24.2±7.2	128.0±71.8
Running (mila) [b,c]	8	182.1±4.8	66.2±3.7	20.0±1.1	19.1±3.1	85.5±30.7	11	171.3±6.5	52.6±6.1	17.9±1.7	18.3±4.0	93.5±51.7
Ultra endurance[a,d]	55	182.3±6.0	75.1±8.7	22.6±1.9	46.4±6.6	86.8±53.1	12	165.3±4.8	58.8±6.4	21.5±2.4	44.3±9.3	85.5±61.7
Team	**138**	**175.8±12.4**	**67.0±15.3**	**21.3±2.7**	**17.6±5.0**	**64.4±37.1**	**104**	**173.6±7.8**	**67.0±7.5**	**22.2±2.0**	**20.8±4.8**	**98.3±57.4**
Soccer youth[c]	63	168.2±12.8	55.5±13.2	19.3±2.1	14.0±1.7	52.8±29.0	16	168.4±6.6	58.4±6.1	20.6±1.5	15.8±0.8	61.4±24.6
Soccer talent[c]	26	179.8±6.2	71.1±5.8	22.0±1.5	17.8±1.6	56.1±32.0	-	-	-	-	-	-
Soccer prof	30	182.0±7.3	78.3±8.7	23.6±1.6	22.9±4.1	78.9±28.1	-	-	-	-	-	-
Volleyball[a,b]	-	-	-	-	-	-	18	184.6±5.8	72.6±5.9	21.3±1.2	18.1±3.7	134.1±70.8
Water polo[c]	12	189.1±7.5	85.6±8.5	23.9±2.0	23.1±8.0	116.5±57.6	12	174.6±3.0	70.3±6.6	23.1±2.3	21.4±4.3	136.7±72.1
Rugby Sevens[a,b]	-	-	-	-	-	-	29	169.0±5.4	66.5±6.1	23.3±1.9	24.0±5.0	85.2±50.7
Hockey C	7	180.9±7.5	73.7±7.0	22.5±0.9	18.5±1.0	47.1±5.7	11	169.3±3.8	61.7±4.7	21.5±1.5	18.5±0.8	76.7±25.6
Handball[a]	-	-	-	-	-	-	18	176.6±4.4	70.7±5.3	22.7±1.5	24.1±3.1	103.9±46.2
Strength	**32**	**182.7±5.5**	**82.3±9.2**	**24.6±2.6**	**21.2±4.9**	**110.5±85.4**	**39**	**166.4±9.2**	**61.1±10.5**	**21.9±2.2**	**20.9±6.7**	**150.9±94.5**
Track cycling[a]	5	186.2±6.3	88.5±6.6	25.5±1.4	19.6±1.1	191.7±53.5	61	172.4±6.8	70.6±10.6	23.6±2.1	19.3±1.2	169.4±54.4
BMX[a,b]	12	180.6±5.3	77.8±10.0	23.8±2.3	19.2±3.3	100.3±88.1	“	“	“	“	“	“
Sprint/bobsled[a,b,c]	4	184.5±3.0	84.6±8.9	24.9±3.0	21.5±1.3	74.6±27.3	8	171.6±4.9	63.5±5.7	21.6±1.5	20.8±3.1	62.7±29.1
Cross fit[d]	5	184.7±4.0	88.6±5.4	26.0±2.1	25.6±7.8	41.3±24.0	6	167.2±5.8	63.3±5.4	22.6±1.3	31.5±9.6	90.0±45.7
Sailing[a]	-	-	-	-	-	-	6	171.6±7.5	64.8±8.3	22.0±2.3	23.0±2.2	163.7±81.9
Gymnastics[a,b]	-	-	-	-	-	-	13	157.7±8.0	52.4±10.2	20.8±2.6	16.0±3.0	218.7±103.0
Archery[a]	6	181.3±6.8	79.2±7.3	24.3±3.9	22.4±6.3	145.1±104.2	-	-	-	-	-	-

[a]National team competing on international level, [b]National youth team competing on international level, [c]Team competing on national level, [d]Reecreative level competing mainly on national level.

1Combination of track cycling and BMX.

Supplemental Table 2 Prevelance and Quantity of Protein Supplemention Among Athletes

Supplementation	Number of athletes (*n*/total *n*)	Dietary Protein Intake (g/kg/d)	Supplemental Protein Intake (g/kg/d)
Strength athletes (*n*=71)			
supplement users	60/71	1.8 ± 0.7	0.3 ± 0.1
non-supplement users	11/71	1.5 ± 0.4	N/A
Team sports athletes (*n*=242)			
supplement users	225/242	1.6 ± 0.4	0.3 ± 0.1
non-supplement users	17/242	1.4 ± 0.4	N/A
Endurance athletes (*n*=240)			
supplement users	214/240	1.7 ± 0.5	0.3 ± 0.2
non-supplement users	26/240	1.5 ± 0.4	N/A