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Case Reports on Well-Trained Bodybuilders: Two Years on a High Protein Diet

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ABSTRACT

Antonio J, Ellerbroek A. Case Reports on Well-Trained Bodybuilders: Two Years on a High Protein Diet. **JEPonline** 2018;21(1):14-24. The purpose of these case studies was to further assess 5 subjects who consumed a high protein diet over an additional 12-month period (for a total of 2 yrs) in order to determine if there were any adverse effects on kidney or liver function. Five healthy resistance trained men (mean ± SD; age 30 ± 5 yrs; height 177.9 ± 5.5 cm) volunteered to consume a high protein diet (>2.2 $g \cdot kg^{-1} \cdot d^{-1}$) over another 1-yr period. They had previously participated in a 1-yr high protein diet study. The subjects came to the lab every 6 months to assess body composition via the Bod Pod®. Body mass, fat mass, lean body mass (LBM), and body fat percentage were ascertained. The subjects provided dietary self-reports via the MyFitnessPal® mobile app at least 3 $times \cdot wk^{-1}$. No other instructions were given. All subjects were provided protein powder so they could attain their protein intake goals. A comprehensive metabolic panel was done in a fasted state at a local Quest Diagnostics facility every 6 months. The findings indicate that 2 yrs of a high protein diet in healthy resistance trained men had no effect on measures of body composition as well as liver or kidney function. Thus, there is no evidence to suggest that consuming a high protein diet over a 2-yr period causes any harmful side effects.

Key Words: Body Composition, Bodybuilding, Diet

INTRODUCTION

The long term effects (>1 yr) of high protein diets (>3 $g \cdot kg^{-1} \cdot d^{-1}$) on body composition and organ function in resistance trained individuals has been largely understudied. The general recommendations for optimal protein intake for building and maintaining skeletal muscle mass is 1.4 to 2.0 $g \cdot kg^{-1} \cdot d^{-1}$ according to the Position Stands of the International Society of Sports Nutrition (8,10). The first high protein study from our laboratory looked at body composition and performance changes after consuming approximately 4.4 $g \cdot kg^{-1} \cdot d^{-1}$ for 8 wks in highly trained individuals (4). The results showed no effects on body composition when consuming a hyper-caloric diet while maintaining the same training regimen.

The follow-up study compared 2.2 $g \cdot kg^{-1} \cdot d^{-1}$ and 3.4 $g \cdot kg^{-1} \cdot d^{-1}$ for 8 wks following a periodized training regimen. This investigation demonstrated that if a high protein is consumed in combination with a change in one's training program, there may be a decrement in fat mass. Furthermore, there were no side effects from the high protein intake (1). This was followed by a 1-yr trial (i.e., protein intake = 2.5 to 3.3 $g \cdot kg^{-1} \cdot d^{-1}$) in 12 highly trained individuals looking at the effects on body composition, blood lipids, liver, and kidney function. The results showed no changes in body composition despite higher total energy intake, as well as no adverse effects (3). However, it is unclear if maintaining a high protein diet for an additional year for a total of 2 yrs will have any deleterious effects. Thus, the purpose of the case studies was to further assess five individuals on a high protein diet over another 1-yr period.

METHODS

Subjects

Five healthy resistance trained men volunteered to continue to consume a high protein diet (>2.2 $g \cdot kg^{-1} \cdot d^{-1}$) over another 1-yr period. They had previously consumed a high protein diet for 1 yr. They were assigned to eat above 2.2 $g \cdot kg^{-1} \cdot d^{-1}$ with no upper limit for the 1-yr period. The additional protein consumed by each subject was whey protein for 4 of the 5 subjects. Whey protein was provided by Dymatize (Dymatize® ISO-100 with 25 g of protein, 1 g of carbohydrate, and 0 g of fat per serving of one scoop). One subject that was vegan was provided with Growing Naturals Pea powder (15 g of protein, 3 g of carbohydrate, and 1.5 g per serving of one scoop). However, the subjects could choose to ingest any source of protein as long as they kept their intake above 2.2 $g \cdot kg^{-1} \cdot d^{-1}$. Subjects came to the university Human Performance Laboratory every 6 months to assess body composition. A basic metabolic panel was assessed at a local Quest Diagnostics facility. The university's Human Subjects Institutional Review Board in accordance with the Helsinki Declaration approved this study, and a written informed consent was obtained prior to the subjects' participation.

Procedures

Food Diary

Each subject kept a food diary for 3 $d \cdot wk^{-1}$ for 1 yr via a smartphone app (MyFitnessPal®) equaling an additional 150 d (150 d had been logged with the previous study) of food logging over the course of 12 months. The MyFitnessPal app is a database comprised of over 5 million foods that have been provided by users via entering data manually or by scanning the bar code on packaged goods. Thus, the data are primarily derived from food labels (i.e., nutrition facts panel) from the USDA National Nutrient database.

Body Composition

The subjects had their height and weight determined using a calibrated scale. They were assessed for body composition via the Bod Pod® while wearing only tight fitting clothing (swimsuit or undergarments) and an acrylic cap. Thoracic gas volume was estimated for all subjects using a predictive equation integral to the Bod Pod® software. Each subject was tested at least twice per visit. The Bod Pod was calibrated the morning of the testing session and between each subject. The subjects were instructed to fast for at least 3 hrs and refrain from exercise the morning of testing.

Blood Analysis: Comprehensive Metabolic Panel

Subjects presented in a fasted state at a local Quest Diagnostics™ facility on five separate occasions. A basic metabolic panel was done. Quest Diagnostics performed each test according to the standard operating procedure of the company.

Statistical Analyses

The data are presented as means ± SD. The statistical analysis was completed using Prism 6 GraphPad Software (La Jolla California).

RESULTS

Group Data

The subjects in the case studies consumed a high protein diet prior to the start of the first year of the study (2.5 $g \cdot kg^{-1} \cdot d^{-1}$). Each subsequent year, their protein intake increased to 3.2 and then 3.5 $g \cdot kg^{-1} \cdot d^{-1}$ (Table 1). Despite consuming a high-protein diet for a period of 2 yrs, measures of liver and kidney function as well as blood glucose remained within the normal clinical range (Table 2).

Table 1. Protein Intake Data of All Subjects.

	Age (yrs)	**Baseline PRO intake** ($g \cdot d^{-1}$)	**Year 1 PRO intake** ($g \cdot d^{-1}$)	**Year 2 PRO intake** ($g \cdot d^{-1}$)	**Baseline PRO intake** ($g \cdot kg^{-1} \cdot d^{-1}$)	**Year 1 PRO intake** ($g \cdot kg^{-1} \cdot d^{-1}$)	**Year 2 PRO intake** ($g \cdot kg^{-1} \cdot d^{-1}$)
Subject 1	25	138	217	255	1.5	2.2	2.6
Subject 2	26	193	278	285	2.7	3.4	3.6
Subject 3	30	395	524	562	4.0	5.1	5.8
Subject 4	31	184	250	222	2.2	3.0	2.7
Subject 5	38	163	198	200	2.0	2.5	2.6
Mean±SD	30.0± 5.1	215±103	293±133	305±147	2.5±1.0	3.2±1.1	3.5±1.4

Data are expressed in yearly average protein intake. **d** = day; **kg** = kilogram; **PRO** = protein

Table 2. Select Clinical Measures of All Subjects.

	Baseline	Year 1	Year 2	Normal Range
Glucose ($mg \cdot dL^{-1}$)	83 ± 6	79 ± 2	86 ± 4	65 to 99 ($mg \cdot dL^{-1}$)
BUN ($mg \cdot dL^{-1}$)	24 ± 6	21 ± 9	24 ± 8	7 to 25 ($mg \cdot dL^{-1}$)
Creatinine ($mg \cdot dL^{-1}$)	1.2 ± 0.4	1.1 ± 0.5	1.2 ± 0.2	0.60 to 1.35 ($mg \cdot dL^{-1}$)
eGFR $mL \cdot min^{-1} \cdot 1.73\ m^{-2}$	97 ± 27	102 ± 26	95 ± 28	> or = 60 $mL \cdot min^{-1} \cdot 1.73\ m^{-2}$
AST U/L	31 ± 8	27 ± 5	28 ± 5	10 to 40 U/L
ALT U/L	29 ± 12	28 ± 11	26 ± 7	9 to 46 U/L

Data are mean ± SD. **ALT** = alanine transaminase; **AST** = aspartate transaminase; **BUN** = blood urea nitrogen; **eGFR** = estimated glomerular filtration rate; **g** = grams; **L** = liter; and **mg** = milligrams. All values fall within the normal range.

Individual Data

In general, the basic metabolic panel data showed no alterations over the course of the 2-yr period with a few exceptions. Subject #4 was the only individual whose values never deviated outside of the normal range. Subject #1 had high BUN levels at baseline and at 2 yrs, but not at year 1. Subject #1 also had elevated creatinine at baseline and year 1, but not at year 2. Subject #2 had high levels of BUN at baseline only. Subject #3 had high levels of BUN at year 1 and 2 but not at baseline. In addition, he had higher levels of creatinine at year 2 and AST at baseline. Subject #5 had high levels of BUN at year 2 only. Table 3 contains all of the individual data.

Table 3. Individual Data of Subjects 1-5.

Subject 1

Body Composition	Baseline	Year 1	Year 2
Body Mass (kg)	93.5	98.1	96.8
Lean Body Mass (kg)	85.2	83.6	87.9
Fat Mass (kg)	8.3	14.4	8.8
Body Fat %	8.9	14.6	9.2

Diet Composition	Baseline	Year 1	Year 2
Protein ($g \cdot d^{-1}$)	138	217	255
Carbohydrate ($g \cdot d^{-1}$)	322	246	244
Fat ($g \cdot d^{-1}$)	103	93	95
Cholesterol ($mg \cdot d^{-1}$)	466	700	569
Sodium ($mg \cdot d^{-1}$)	4510	4545	4391
Sugar ($g \cdot d^{-1}$)	103	85	69
Fiber ($g \cdot d^{-1}$)	24	21	25

Metabolic Panel	Baseline	Year 1	Year 2	Normal Range
Glucose ($mg \cdot dL^{-1}$)	85	75	84	65 to 99 $mg \cdot dL^{-1}$
BUN ($mg \cdot dL^{-1}$)	33*	24	26*	7 to 25 $mg \cdot dL^{-1}$
Creatinine ($mg \cdot dL^{-1}$)	1.44*	1.46*	1.30	0.60 to 1.35 $mg \cdot dL^{-1}$
eGFR	68	66	72	> or = 60 $mL \cdot min^{-1} \cdot 1.73\ m^{-2}$
AST U/L	34	20	32	10 to 40 U/L
ALT U/L	26	16	24	9 to 46 U/L

ALT = alanine transaminase; **AST** = aspartate transaminase; **BUN** = blood urea nitrogen; **g** = gram; **d** = day; **dl** = deciliter; **eGFR** = estimated glomerular filtration rate; **kg** = kilogram; **UL** = units per liter; *Outside of the normal range

Subject 2

Body Composition	Baseline	Year 1	Year 2
Body Mass (kg)	72.9	80.4	78.9
Lean Body Mass (kg)	59.4	56.9	59.5
Fat Mass (kg)	13.5	23.4	19.4
Body Fat %	18.6	27.4	24.6

Diet Composition	Baseline	Year 1	Year 2
Protein ($g \cdot d^{-1}$)	193	278	285
Carbohydrate ($g \cdot d^{-1}$)	187	350	261
Fat ($g \cdot d^{-1}$)	83	72	76
Cholesterol ($mg \cdot d^{-1}$)	539	403	500
Sodium ($mg \cdot d^{-1}$)	3932	2160	1799
Sugar ($g \cdot d^{-1}$)	89	50	33
Fiber ($g \cdot d^{-1}$)	15	21	27

Metabolic Panel	Baseline	Year 1	Year 2	Normal Range
Glucose ($mg \cdot dL^{-1}$)	89	78	85	65 to 99 ($mg \cdot dL^{-1}$)
BUN ($mg \cdot dL^{-1}$)	26*	12	16	7 to 25 ($mg \cdot dL^{-1}$)
Creatinine ($mg \cdot dL^{-1}$)	0.97	0.90	1.02	0.60 to 1.35 ($mg \cdot dL^{-1}$)
eGFR	126	117	117	> or = 60 $mL \cdot min^{-1} \cdot 1.73\ m^{-2}$
AST U/L	35	30	28	10 to 40 U/L
ALT U/L	42	32	25	9 to 46 U/L

ALT = alanine transaminase; **AST** = aspartate transaminase; **BUN** = blood urea nitrogen; **g** = gram; **d** = day; **dl** = deciliter; **eGFR** = estimated glomerular filtration rate; **kg** = kilogram; **UL** = units per liter; *Outside of the normal range

Subject 3

Body Composition	Baseline	Year 1	Year 2
Body Mass (kg)	99.1	95.1	97.7
Lean Body Mass (kg)	81.7	80.3	85.4
Fat Mass (kg)	17.9	21.9	12.3
Body Fat %	17.6	15.3	12.6

Diet Composition	Baseline	Year 1	Year 2
Protein ($g \cdot d^{-1}$)	395	524	562
Carbohydrate ($g \cdot d^{-1}$)	107	180	122
Fat ($g \cdot d^{-1}$)	48	109	108
Cholesterol ($mg \cdot d^{-1}$)	50	871	1322
Sodium ($mg \cdot d^{-1}$)	1210	4236	4905
Sugar ($g \cdot d^{-1}$)	13	32	25
Fiber ($g \cdot d^{-1}$)	42	46	23

Metabolic Panel	Baseline	Year 1	Year 2	Normal Range
Glucose ($mg \cdot dL^{-1}$)	77	79	89	65 to 99 ($mg \cdot dL^{-1}$)
BUN ($mg \cdot dL^{-1}$)	25	33*	34*	7 to 25 ($mg \cdot dL^{-1}$)
Creatinine ($mg \cdot dL^{-1}$)	1.26	1.02	1.50*	0.60 to 1.35 ($mg \cdot dL^{-1}$)
eGFR	76	97	61	> or = 60 $mL \cdot min^{-1} \cdot 1.73\ m^{-2}$
AST U/L	42*	32	32	10 to 40 U/L
ALT U/L	42	45	38	9 to 46 U/L

ALT = alanine transaminase; **AST** = aspartate transaminase; **BUN** = blood urea nitrogen; **g** = gram; **d** = day; **dl** = deciliter; **eGFR** = estimated glomerular filtration rate; **kg** = kilogram; **UL** = units per liter; *Outside of the normal range

Subject 4

Body Composition	Baseline	Year 1	Year 2
Body Mass (kg)	82.7	82.6	80.8
Lean Body Mass (kg)	70.9	70.1	68.9
Fat Mass (kg)	11.7	12.5	11.7
Body Fat %	14.3	15.1	14.6

Diet Composition	**Baseline**	**Year 1**	**Year 2**
Protein (g·d^{-1})	184	250	222
Carbohydrate (g·d^{-1})	405	388	332
Fat (g·d^{-1})	43	85	69
Cholesterol (mg·d^{-1})	90	12	6
Sodium (mg·d^{-1})	3066	4225	3522
Sugar (g·d^{-1})	29	65	83
Fiber (g·d^{-1})	71	50	60

Metabolic Panel	**Baseline**	**Year 1**	**Year 2**	**Normal Range**
Glucose (mg·dL^{-1})	76	81	82	65 to 99 (mg·dL^{-1})
BUN (mg·dL^{-1})	18	12	19	7 to 25 (mg·dL^{-1})
Creatinine (mg·dL^{-1})	0.95	0.85	1.30	0.60 to 1.35 (mg·dL^{-1})
eGFR	125	135	125	> or = 60 mL·min^{-1}·1.73 m^{-2}
AST U/L	25	27	28	10 to 40 U/L
ALT U/L	15	24	22	9 to 46 U/L

ALT = alanine transaminase; **AST** = aspartate transaminase; **BUN** = blood urea nitrogen; **g** = gram; **d** = day; **dl** = deciliter; **eGFR** = estimated glomerular filtration rate; **kg** = kilogram; **UL** = units per liter; *Outside of the normal range

Subject 5

Body Composition	**Baseline**	**Year 1**	**Year 2**
Body Mass (kg)	82.5	78.1	77.8
Lean Body Mass (kg)	68.2	65.3	66.7
Fat Mass (kg)	14.2	12.7	11.0
Body Fat %	17.3	16.4	14.2

Diet Composition	**Baseline**	**Year 1**	**Year 2**
Protein (g·d^{-1})	163	198	200
Carbohydrate (g·d^{-1})	205	197	252
Fat (g·d^{-1})	73	67	78
Cholesterol (mg·d^{-1})	691	348	369
Sodium (mg·d^{-1})	4606	3427	3609
Sugar (g·d^{-1})	49	58	86
Fiber (g·d^{-1})	20	27	27

Metabolic Panel	Baseline	Year 1	Year 2	Normal Range
Glucose ($mg \cdot dL^{-1}$)	88	80	92	65 to 99 ($mg \cdot dL^{-1}$)
BUN ($mg \cdot dL^{-1}$)	18	23	31*	7 to 25 ($mg \cdot dL^{-1}$)
Creatinine ($mg \cdot dL^{-1}$)	1.25	1.18	1.13	0.60 to 1.35 ($mg \cdot dL^{-1}$)
eGFR	89	95	99	> or = 60 $mL \cdot min^{-1} \cdot 1.73\ m^{-2}$
AST U/L	21	24	21	10 to 40 U/L
ALT U/L	20	22	23	9 to 46 U/L

ALT = alanine transaminase; **AST** = aspartate transaminase; **BUN** = blood urea nitrogen; **g** = gram; **d** = day; **dl** = deciliter; **eGFR** = estimated glomerular filtration rate; **kg** = kilogram; **UL** = units per liter; *Outside of the normal range

DISCUSSION

Kidney and Liver Function

This is the fifth study in a series of investigations that have examined the effects of a high protein diet (≥2.2 $g \cdot kg^{-1} \cdot d^{-1}$) (1-4). The five resistance trained males in the current study had consumed a high protein diet for 2 yrs. The mean values for all of the parameters (group data) showed no harmful effects of protein consumption. When the individual data were examined, a few of the clinical values were slightly outside of the normal range. However, there was no consistent pattern. Subject #4 was the only individual whose values never deviated outside of the normal range. In general, four subjects had elevated BUN levels, whereas two had elevated creatinine levels. However, there was no temporal pattern to this finding.

Interestingly, acute exercise by itself can result in an increase in BUN and creatinine (9). For instance, “concentrations of glucose, total protein, albumin, uric acid, calcium, phosphorus, serum urea nitrogen, creatinine, bilirubin, alkaline phosphatase, alanine aminotransferase, aspartate aminotransferase, total creatine kinase, creatine kinase-MB, myoglobin, and the anion gap were increased after a marathon race, which is consistent with the effects of exertional rhabdomyolysis and hemolysis” (13). Also, post-marathon creatinine as well as other markers of muscle damage were elevated (12).

Our subjects were well-trained bodybuilders. Thus, it is not clear if the volume of training they performed was sufficient to produce a rise in creatinine or BUN. On the other hand, we did not control for their training or exercise. Thus, it is entirely possible that the acute exercise may have altered their blood chemistry values. Nevertheless, when one examines the group mean, there were no untoward alterations in their blood chemistry.

Higher protein consumption has been shown to elevate GFR levels, as reported in a study by Bilo et al. (6) in 6 subjects with normal renal function, as well as 9 subjects with chronic renal insufficiency. During this investigation, different kinds of protein sources were tested (beef, lactoprotein, and soy). Beef consumption, chronic and acute, showed the highest response in elevating GFR levels, compared to the other protein sources in both the groups tested. On the other hand, the Nurse’s Health Study (11) assessed higher protein intake in 1624 women (42 to 68 yrs) from 1989 to 2000. They found that “high protein intake was not associated with renal function decline in women with normal renal function. However, high total protein intake, particularly high intake of nondairy animal protein, may accelerate renal function decline in women with mild renal insufficiency." Work by Berryman et al. (5) looked at higher protein intake from animal, dairy, and plant sources (mean ± SE total protein intake 82.3 ± 0.8 $g \cdot d^{-1}$) in 11,111 adults with the use of 24-hr recall. They concluded that higher plant and animal protein intake was associated with no negative effects on kidney function, improved central adiposity, and cardio-metabolic benefits. A 7-day study by Poortmans et al. (16) concluded that protein intake under 2.8 $g \cdot kg^{-1} \cdot d^{-1}$ does not impair renal function in well-trained athletes.

It is clear from our investigations and others that the consumption of a high-protein diet, particularly in healthy exercise trained individuals has no harmful effect on renal function (1-3,7,15,16). The concern over higher protein intake on the liver was raised in a review by Bilsborough and Mann (7). They stated that high protein diets of 200 to 400 $g \cdot d^{-1}$, which can equate to levels of approximately 5 $g \cdot kg^{-1} \cdot d^{-1}$, may exceed the liver's capacity to convert excess nitrogen to urea. Yet, interestingly, this speculation is not supported by research findings. In fact, our data in human subjects consuming >200 grams of protein daily showed no effect on markers of liver function (i.e., AST and ALT). The resistance trained subjects in our investigation consumed more than 2.2 grams of protein per kilogram of body weight per day for the 2 yrs.

Body Composition

The five resistance trained males (>9 yrs of training) demonstrated for the most part rather inconsistent changes in body composition. There were no clear trends in lean body mass or fat mass. Our prior investigations (1,2) have shown that a higher intake of protein with or without a change in training might promote a loss of fat mass. Nonetheless, it is unclear why higher protein intakes may promote a loss of fat mass in the short-term, but have no lasting effect over the course of years. Perhaps, in the short term, changes in exercise energy expenditure and, perhaps, non-exercise activity thermogenesis (NEAT) might account in part for the greater changes in body composition in those that consume large quantities of protein (14,18).

According to Levine et al. (14), NEAT can vary between individuals by as much as 2000 kcals daily. Therefore, one might speculate that the more advanced training status of the high protein group might lend itself to greater NEAT. Protein has a thermic effect of feeding (TEF) of 19 to 23% in both obese and lean individuals. On the other hand, carbohydrate is approximately 12 to 14% (17). We would speculate that the primary effect of protein overfeeding is in the effect on NEAT. Future work should examine the effect of protein overfeeding on NEAT to determine if this is the cause, at least in the short-term, of the decrement in fat mass.

Limitations of this Study

One of the limitations of this investigation is the case study design. Nonetheless, it is clear that at least in this small cohort of resistance trained men, there were no harmful effects of a high protein diet. Another limitation of this study is the use of dietary self-reports. Subjects were provided protein powder to help maintain the additional protein, which could provide for a more accurate recall if they ingested it as the additional protein source added to their normal daily diet.

CONCLUSIONS

This is the first 2-yr investigation in resistance-trained males on the effects of consuming a high protein diet. We found no deleterious effects on liver or kidney function. Furthermore, there were no significant alterations in body composition. Future studies should focus on continuing to monitor exercise trained individuals on the effects of a high protein diet for longer periods of time. Also, studies in women are non-existent in relation to higher protein intakes.

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REFERENCES

1. Antonio J, Ellerbroek A, Silver T, Orris S, Scheiner M, Gonzalez A, Peacock CA. A high protein diet (3.4 g/kg/d) combined with a heavy resistance training program improves body composition in healthy trained men and women: A follow-up investigation. ***J Int Soc Sports Nutr.*** 2015;12:39.

2. Antonio J, Ellerbroek A, Silver T, Vargas L, Peacock C. The effects of a high protein diet on indices of health and body composition: A crossover trial in resistance-trained men. ***J Int Soc Sports Nutr.*** 2016;13:3.

3. Antonio J, Ellerbroek A, Silver T, Vargas L, Tamayo A, Buehn R, Peacock CA. A high protein diet has no harmful effects: A one-year crossover study in resistance-trained males. ***J Nutr Metab.*** 2016;9104792.

4. Antonio J, Peacock CA, Ellerbroek A, Fromhoff B, Silver T. The effects of consuming a high protein diet (4.4 g/kg/d) on body composition in resistance-trained individuals. ***J Int Soc Sports Nutr.*** 2014;11:19.

5. Berryman CE, Agarwal S, Lieberman HR, Fulgoni VL, 3rd, Pasiakos SM. Diets higher in animal and plant protein are associated with lower adiposity and do not impair kidney function in US adults. ***Am J Clin Nutr.*** 2016;104:743-749.

6. Bilo HJ, Schaap GH, Blaak E, Gans RO, et al. Effects of chronic and acute protein administration on renal function in patients with chronic renal insufficiency. ***Nephron.*** 1989;53:181-187.

7. Bilsborough S, Mann N. A review of issues of dietary protein intake in humans. ***Int J Sport Nutr Exerc Metab.*** 2006;16:129-152.

8. Campbell B, Kreider RB, Ziegenfuss T, La Bounty P, Roberts M, Burke D, Landis J, Lopez H, Antonio J. International Society of Sports Nutrition Position Stand: Protein and Exercise. ***J Int Soc Sports Nutr.*** 2007;4:8.

9. Foran SE et al. Effects of exercise on laboratory test results. ***Lab Med.*** 2003;34:736-742.

10. Jager R, Kerksick CM, Campbell BI, Cribb PJ, Wells SD, Skwiat TM, Purpura M, Ziegenfuss TN, Ferrando AA, Arent SM, et al. International Society of Sports Nutrition Position Stand: Protein and Exercise. ***J Int Soc Sports Nutr.*** 2017; 14:20.

11. Knight EL, Stampfer MJ, Hankinson SE, Spiegelman D, Curhan GC. The impact of protein intake on renal function decline in women with normal renal function or mild renal insufficiency. ***Ann Intern Med.*** 2003;138:460-467.

12. Kraemer RR, Brown BS. Alterations in plasma-volume-corrected blood components of marathon runners and concomitant relationship to performance. ***Eur J Appl Physiol Occup Physiol.*** 1986;55:579-584.

13. Kratz A, Lewandrowski KB, Siegel AJ, Chun KY, Flood JG, Van Cott EM, Lee-Lewandrowski E. Effect of marathon running on hematologic and biochemical laboratory parameters, including cardiac markers. ***Am J Clin Pathol.*** 2002;118:856-863.

14. Levine JA, Vander Weg MW, Hill JO, et al. Non-exercise activity thermogenesis: The crouching tiger hidden dragon of societal weight gain. ***Arterioscler Thromb Vasc Biol.*** 2006;26:729-736.

15. Martin WF, Armstrong LE, Rodriguez NR. Dietary protein intake and renal function. ***Nutr Metab (Lond).*** 2005;2:25.

16. Poortmans JR, Dellalieux O. Do regular high protein diets have potential health risks on kidney function in athletes? ***Int J Sport Nutr Exerc Metab.*** 2000;10:28-38.

17. Swaminathan R, King RF, Holmfield J, Siwek RA, Baker M, Wales JK. Thermic effect of feeding carbohydrate, fat, protein and mixed meal in lean and obese subjects. ***Am J Clin Nutr.*** 1985;42:177-181.

18. Teske JA, Billington CJ, Kotz CM. Neuropeptidergic mediators of spontaneous physical activity and non-exercise activity thermogenesis. ***Neuroendocrinol.*** 2008;87: 71-90.

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