

Dietary Protein & Weight Management

2010

This document summarizes the scientific background for several structure function claims and other statements regarding higher dietary protein and weight management.

Scientific Backgrounder

Regulatory Affairs
Dairy Research Institute

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Introduction

This **Scientific Backgrounder** provides scientific background for several structure function claims and other statements regarding whey protein and weight management.

These food messages may be considered for use in various types of communications. Compliance with regulatory requirements and industry standards set forth by the U.S. Food and Drug Administration (FDA), the Federal Trade Commission (FTC) and other governing agencies is critical.

The term “labeling” is defined broadly in the Food, Drug and Cosmetic Act (section 201(m)) as ‘*all labels and other written, printed, or graphic matter upon any article or any of its containers or wrappers or accompanying such article.*’ FDA has indicated that labeling is not limited to actual labels on a food product, but also includes “brochures, booklets...motion picture films, film strips, sound recordings ... and similar pieces of printed, audio, or visual matter ... which are disseminated by or on behalf of its manufacturer, packer, or distributor...” Thus, products that are promoted through written, printed, or graphic matter that supplement or explain the product for use in the distribution and sale of the product, such as flyers and brochures in proximity to a product on a shelf in a grocery store, are likely to be considered “labeling.” FDA has also indicated that information provided on a website that offers a product for sale, meaning that the product can be ordered through the site for delivery or when the product links to such a site, will be viewed as labeling. [Source: Food Regulation. Law, Science, Policy, and Practice. Neal D. Fortin, J.D. Published by John Wiley & Sons, Inc. Hoboken, New Jersey. 2009]

The FTC is responsible for protecting consumers from unfair or deceptive acts or practices and oversees food advertising, which includes materials available on the Internet. FTCs oversight broadly covers advertising materials, promotional activities, and marketing and sales practices in general and includes traditional print, television, telephone and radio advertising and well as materials provided on the internet for the purposes of promoting the sale of a product. The FTC periodically joins with other law enforcement agencies to monitor the Internet for potentially false or deceptive online advertising claims. When advertising materials do not comply with the law, enforcement actions or civil lawsuits may be taken.

The FTC requires that advertising materials be truthful and not misleading and that advertisers have supportive evidence (substantiation) to back up their claims. A claim may be considered misleading if relevant information is left out or if the claim implies something that's not true. A claim can be considered unsubstantiated without adequate documented support. FTC has published a number of rules and guidance documents to help businesses comply with the law (e.g. Enforcement Policy Statement on Food Advertising; FTC Policy Statement Regarding Advertising Substantiation; Advertising and Marketing on the Internet Rules of the Road; Dietary

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Supplements An Advertising Guide for Industry; Statement of Policy Regarding Comparative Advertising); for more information see <http://www.ftc.gov/bcp/guides/guides.shtm>.

This **Scientific Backgrounder** provides a summary of scientific research about dietary protein and weight management. See the companion **Reference Guide** for a general overview of nutrition labeling terms and requirements associated with use of messages for claims about whey protein on food labels or in labeling. This **Scientific Backgrounder** is only intended as a general summary of information and is not intended to take the place of either the written law or regulations. Since regulations may change over time, it is important to consult the most current regulations prior to making any claims. The Dairy Research Institute expresses no opinion about the suitability of the information for use and suggests that any recipient obtain appropriate expert advice with regard to any statements or information herein contained (*see footer*).

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Scientific Backgrounder: Protein, including whey, and weight management

This document has been prepared to summarize the scientific support for several structure function claims and other statements regarding higher dietary protein and weight management. Adequate support for the following claims is provided in this document (note these claims are presented as model claims and slight wording changes may be possible):

- Diets higher in protein may/can help in weight management
- Diets higher in protein may/can fit in your weight loss plan
- Diets higher in protein may/can fit into your weight maintenance plan.

Each of the above statements could insert the phrase “including whey protein containing foods” after “Diets higher in protein.” Messages about weight maintenance and keeping weight loss from returning may, depending on context, require additional disclosure statements to ensure the consumer fully understands the messages. This may include noting in promotional materials that individual results may vary.

Summary and conclusions of Literature Review

There are several review articles and meta-analyses published on effects of high-protein diets on weight management (Bravata *et al.*, 2003; Krieger *et al.*, 2006; Last & Wilson, 2006; Nordmann *et al.*, 2006, 2006). In this document we summarize 121 interventions from 72 published studies published through the end of 2007. We have only included studies that provided protein levels greater than the RDA level (0.8 g/kg or 56 g/day). The majority of these studies (n=57) were described in Krieger *et al.* (2006). We have also included 15 additional studies, with an additional 31 interventions, that have been published since this review.

Table 1 presents all the data for these studies which were conducted in men and/or women, varied in duration ranging from 4 weeks to one year, and had protein intake ranging from 0.9 to 2.2 g/kg per day (63-154 g/day). Examining the mean and standard errors **we can conclude that 98 of the 121 (81 %) interventions resulted in significantly greater weight loss than zero.** Fifteen of the interventions in Table 1 exceeded 10, 000 kj per day (2388 kcal/day) and would be considered maintenance diets rather than weight loss diets; even in these diets 10 of 15 (67%) interventions resulted in significant weight loss, albeit a much smaller amount.

To manage calories as one macronutrient goes up another typically has to be reduced; this usually means reducing fat or carbohydrates in the diet. Carbohydrate intake ranged from a low of 8.5 g/d to 443 g/day in these studies.

While not all conditions in interventions presented in Table 1 focused on weight management and not all the interventions led to a significant weight loss, the **preponderance of the**

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evidence supports the that higher protein diets can help with weight management and even weight loss, thus fitting into weight loss and weight maintenance plans.

For labeling purposes, declaration of the percent daily value (%DV) is not required unless a claim about the protein content of the food is made. Manufacturers may voluntarily include the %DV for protein, however, if reported, the value must be based on the *protein digestibility-corrected amino acid score* (PDCAAS) method which addresses the quality of the protein (see 21 CFR 101.9). The PDCAAS value is used together with the g of protein to derive the %DV for protein in a food. Determination of the PDCAAS value can require rather expensive and sophisticated analyses, so many foods, including those that do not have complete protein, do not report %DV.

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Applying Research Summary

Current protein intake in America is 70 and 102 g/day in adult females and males, respectively.

Trends in Protein Intake						
	2001-2002		2003-2004		2005-2006	
	Males	Females	Males	Females	Males	Females
12-19 years	93.2 ± 2.2	65.3 ± 1.3	94.0 ± 3.1	67.8 ± 1.3	99.1 ± 3.1	64.2 ± 1.7
20+ years	97.7 ± 1.3	67.6 ± 1.1	98.6 ± 1.1	68.5 ± 1.3	101.9 ± 1.8	70.1 ± 1.4
Males and Females, 2 years and older	79 ± 0.8		80 ± 0.9		82 ± 1.2	
DATA SOURCE: What We Eat in America, NHANES, 2001-2002, 2003-2004, and 2005-2006; individuals 2 years and over (excluding breast-fed children), Day 1 dietary sampling weights. U.S. Department of Agriculture, Agricultural Research Service. Available: www.ars.usda.gov/ba/bhnrc/fsrg .						

Claims that may be made about higher protein diets and weight management are considered structure/function claims. FDA specifies that structure/function claims should be based on a meaningful amount of the nutrient or dietary substance in the product and all claims should be truthful and not misleading. For individual products with protein, 10% of the Daily Value or more is consistent with the qualifying criteria for a nutrient content claim as established by FDA. The Daily Reference Value of protein for adults and children over 4, which forms the basis for calculating the Daily Value, is 50 grams. Thus, products with 5 g protein per reference amount customarily consumed, including products with whey protein, may consider conveying messages cited within.

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Table 1. Summary of studies evaluating high protein diets on weight management

Reference	Age Y	Sex	Duration wk	Protein g/kg (g/d)	Energy Intake kJ	Changes	
						Body mass kg	Fat-free mass kg
Alford et al, 1990 <i>n</i> = 12	40.5 ± 5.9	F	10	1.21	5040	-6.4 ± 2.2	-0.6
Archer et al, 2003 (25) <i>n</i> = 31	36.5 ± 9.6	M	6.5	1.36	12 760	-2.2 ± 3.4	NA
<i>n</i> = 32	39.1 ± 12.5	M	6.5	1.27	12 499	-2.1 ± 3.9	NA
Ashley, et al, 2007 <i>n</i> = 35	39.8	F	52	65.5	5729	-6.1 ± 1.5	NA
Baba et al, 1999 (26) <i>n</i> = 7	NA	M	4	1.78	7523	-8.3 ± 0.7	-1.0 ± 0.3
Bowen et al, 2004 (27) <i>n</i> = 25	47.0 ± 10.0	M, F	12	1.09	5821	-9.0 ± 0.6	NA
<i>n</i> = 25	47.0 ± 10.0	M, F	12	1.12	5936	-9.3 ± 0.7	NA
Bray et al, 2002 (28) <i>n</i> = 14	37.0 ± 9.8	M	12	1.07	11 956	-3.7 ± 0.5	-0.4 ± 0.3
<i>n</i> = 14	36.1 ± 9.6	M	12	1.15	12 256	-2.5 ± 0.6	-0.9 ± 0.3
Brehm et al, 2005 (4) <i>n</i> = 20	44.8 ± 10.7	F	16	1.01	5902	-9.8 ± 0.7	-3.3 ± 0.9
Coleman et al, 2005 (31) <i>n</i> = 13	39.2 ± 3.7	F	12	1.09	6447	-7.0 ± 4.8	NA
Doi et al, 2001 (33)							

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$n = 8$	34.0 ± 7.4	M	12	1.07	8043	-4.1 ± 2.2	-2.0 ± 1.1
$n = 9$	33.1 ± 6.9	M	12	1.1	8007	-4.2 ± 2.2	-1.8 ± 1.0
Farnsworth et al, 2003 (11)							
$n = 21$	50.6 ± 12.4	F	12	1.15	6300	-6.6 ± 0.5	-0.1 ± 0.3
Finkelstein et al, 1971 (34)4							
$n = 4$	21.0 ± 0.5	F	4.29	1.62	7140	-2.1 ± 0.5	NA
			4.29	1.54	5880	-3.5 ± 0.5	NA
$n = 4$	21.0 ± 0.5	F	4.29	1.5	7140	-2.6 ± 0.9	NA
			4.29	1.43	5880	-3.5 ± 0.7	NA
Gannon et al, 2004 (35)							
$n = 8$	63.3 ± 11	M	5	1.07	11 865	-1.8 ± 6.4	NA
$n = 8$	63.3 ± 11	M	5	2.14	11 865	-1.8 ± 6.1	NA
Gerhard et al, 2004 (36)							
$n = 11$	50.4 ± 4.8	M, F	6	1.08	12184	-0.5 ± 0.3	NA
Geliebter et al, 1997 (37)							
$n = 20$	35.0 ± 6.0	M, F	8	1.28	5375	-7.8 ± 0.9	-1.1 ± 0.5
$n = 22$	36.0 ± 8.0	M, F	8	1.32	5375	-9.5 ± 0.7	-2.7 ± 0.5
$n = 23$	36.0 ± 7.0	M, F	8	1.34	5375	-9.6 ± 0.9	-2.3 ± 0.5
Hays et al, 2004 (41)							
$n = 11$	67.5 ± 7.3	M, F	14	1.21	9450	-3.2 ± 1.2	-0.5
$n = 11$	64.8 ± 6.6	M, F	14	1.39	10 135	-4.8 ± 0.9	-0.2

Johnston et al., 2006

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Table 1. Summary of studies evaluating high protein diets on weight management

n = 9	28.4	M,F	6	125	6250	-6.3 ± 0.6	NA
n = 10	37.2	M,F	6	117	6250	-7.2 ± 0.8	NA
Jenkins et al, 2003 (44)							
<i>n</i> = 12	60.0 ± 9.9	M, F	4	1.54	10 172	-0.9 ± 0.3	NA
<i>n</i> = 13	60.0 ± 9.9	M, F	4	1.62	10 189	-1.0 ± 0.4	NA
Johnston et al, 2004 (45)							
<i>n</i> = 9	40.1 ± 10.8	M, F	6	1.63	7080	-4.7 ± 0.6	-1.9
Keim et al, 1997 (47)5							
<i>n</i> = 10	29.4 ± 5.4	F	6	1.12	8000	-3.9 ± 0.2	-1.3 ± 0.1
			6	1.14	8000	-3.3 ± 0.3	-0.3 ± 0.2
Keim et al, 1998 (48)							
<i>n</i> = 12	31.0 ± 3.5	F	12	1.08	8000	-7.0 ± 0.5	-0.9
Keogh et al., 2007)							
n = 19	48	M,F	52	84	6936	-7.5 ± 5.1	NA
n = 19	52	M,F	52	105	7703	-5.3 ± 3.8	NA
Landry et al, 2003 (52)							
<i>n</i> = 19	34.0 ± 10.0	M	7	1.37	12 000	-2.5 ± 0.6	NA
Larosa et al, 1980 (53)							
<i>n</i> = 10	39.0 ± 9.5	F	8	1	4898	-6.9 ± 1.5	NA
<i>n</i> = 14	39.0 ± 9.5	M	8	1.23	6955	-6.4 ± 1.0	NA

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Table 1. Summary of studies evaluating high protein diets on weight management

Layman et al, 2003 (9)									
<i>n</i> = 12	50.1 ± 5.4	F	10	1.47	6987		-7.5 ± 1.4	-9 ± 0.3	
Leidy et al, 2004 (54)									
<i>n</i> = 10	20.3 ± 1.6	F	12	1.25	8442		-3.2 ± 0.8	-0.6 ± 0.7	
Leidy et al., 2007									
<i>n</i> = 21	53	F	12	67	6280		-9.5 ± 1.00	-2.8 ± 0.5	
<i>n</i> = 25	46	F	12	115	6448		-8.1 ± 0.4	-1.5 ± 0.3	
Lofgren et al., 2005									
<i>n</i> = 70	29.4	F	10	105.8	6304		-3.5 ± 1.9	-1.7 ± 0.8	
Luscombe et al., 2006									
<i>n</i> = 11	50	M,F	10	74.9	5700		-11.7 ± 1.8	-3.8 ± 0.7	
Luscombe et al, 2003 (12)									
<i>n</i> = 17	55.0 ± 8.2	M, F	12	1.1	6358	-	7.9 ± 1.1 NA	NA	
Luscombe-Marsh et al, 2005 (58)									
<i>n</i> = 12	50.0 ± 10.4	M	12	1.30	6164		-10.5 ± 1.7	-3.9 ± 0.	
<i>n</i> = 15	53.0 ± 7.7	F	12	1.44	6164		-7.8 ± 0.8	-2.2 ± 0.5	
Mahon et al., 2007									
<i>n</i> = 14	58	F	9	67	4664		-6.6 ± 3.6	-2.2 ± 1.2	
<i>n</i> = 15	58	F	9	67	4597		-7.9 ± 3.8	-2.3 ± 1.6	
<i>n</i> = 11	58	F	9	70	6573		-1.2 ± 5.0	0 ± 5.0	

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Table 1. Summary of studies evaluating high protein diets on weight management

Maki et al., 2007								
n = 43	51.4	M,F	12	70	6280	-2.5 ± 0.5	-2.2 ± 0.2	
Meckling et al, 2002 (60)								
<i>n = 20</i>	<i>34.4 ± 11.4</i>	<i>F</i>	<i>8</i>	<i>1.06</i>	<i>5736</i>	<i>-5.0 ± 1.1</i>	<i>-1.0 ± 0.6</i>	
Meckling et al, 2004 (61)								
<i>n = 15</i>	<i>41.2 (27–61)</i>	<i>M, F</i>	<i>10</i>	<i>1.11</i>	<i>6421</i>	<i>-7.0 ± 4.0</i>	<i>-1.9 ± 1.1</i>	
Meckling & Sherfey, 2007								
n = 10	45	F	8	84	5787	-4.6 ± 22.4	0.9 ± 6.1	
n = 14	37	F	8	115	5094	-7.0 ± 4.8	-0.5 ± 2.0	
Millan-Price et al., 2006								
n = 32	31.8	M,F	12	63	6010	-3.7 ± 0.5	-0.5 ± 0.2	
n = 32	30.5	M,F	12	69	6150	-4.8 ± 0.5	-0.3 ± 0.2	
n = 32	30.2	M,F	12	95	5950	-5.3 ± 0.5	-0.6 ± 0.2	
n = 33	34.6	M,F	12	93	5970	-4.4 ± 0.5	-0.4 ± 0.2	
Moran et al., 2006								
n = 34	32.7	F	8	70.9	4904	-5.6 ± 3.3	NA	
Moriguti et al, 2000 (63)								
<i>n = 11</i>	<i>25.7 ± 3.2</i>	<i>M, F</i>	<i>6</i>	<i>1.17</i>	<i>8009</i>	<i>-3.1 ± 0.3</i>	<i>-1.4 ± 0.3</i>	
<i>n = 12</i>	<i>25.8 ± 3.6</i>	<i>M, F</i>	<i>6</i>	<i>1.12</i>	<i>9954</i>	<i>-4.3 ± 0.3</i>	<i>-1.5 ± 0.4</i>	
<i>n = 18</i>	<i>68.4 ± 3.3</i>	<i>M, F</i>	<i>6</i>	<i>1.14</i>	<i>6577</i>	<i>-4.8 ± 0.2</i>	<i>-1.6 ± 0.2</i>	

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Table 1. Summary of studies evaluating high protein diets on weight management

Noakes et al, 2005 (68)								
<i>n</i> = 52	50.0 ± 10.0	F	12	1.14	5310	-7.6 ± 0.4	-1.5 ± 0.3	
Parker et al, 2002 (10)								
<i>n</i> = 9	63.4 ± 5.1	M	8	1.04	6665	-4.7 ± 8.2	-1.5	
<i>n</i> = 17	58.7 ± 9.1	F	8	1.2	6665	-6.0 ± 5.2	-0.7	
Pereira et al, 2004 (69)								
<i>n</i> = 22	28.8 ± 6.3	M, F	9.3	1.1	6300	-9.6 ± 0.3	-2.7	
Prewitt et al, 1991 (71)								
<i>n</i> = 6	34.8 ± 5.9	F	20	1.15	9160	-2.1 ± 8.5	1.6 ± 0.7	
<i>n</i> = 12	28.5 ± 12.1	F	20	1.53	8047	-1.9 ± 4.1	0.8 ± 0.8	
Pittas et al., 2006								
<i>n</i> = 16	34.3	M,F	24	100.9	8445	-7.2 ± 1.1	NA	
<i>n</i> = 16	35	M,F	24	147.9	8256	-7.7 ± 0.8	NA	
Raatz et al., 2005								
<i>n</i> = 10	NA	M,F	36	70.5	7833	-9.3 ± 1.3	-4.8 ± 2.2	
<i>n</i> = 10	NA	M,F	36	70.5	7833	-8.4 ± 1.5	-2.6 ± 1	
<i>n</i> = 10	NA	M,F	36	70.5	7833	-10.0 ± 1.4	-3.0 ± 0.6	
Roy et al, 2002 (74)								
<i>n</i> = 5	25.8 ± 2.0	F	4	1.05	8478	-1.8 ± 0.5	-1.0 ± 2.	
<i>n</i> = 5	24.6 ± 2.9	F	10	1.21	7602	-3.1 ± 0.4	-0.1 ± 2.8 -	

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Table 1. Summary of studies evaluating high protein diets on weight management

Saltzman et al, 2001 (76)								
<i>n</i> = 21	44.1 ± 21.3	M, F	6	1.05	7833	-4.0 ± 0.2	-1.3	
<i>n</i> = 22	45.1 ± 22.7	M, F	6	1.05	7645	-3.9 ± 0.3	-1.4	
Saltzman et al, 2001B (77)								
<i>n</i> = 20	45.0 ± 21.5	M, F	6	1.19	8114	-4.4 ± 0.3	-1.4 ± 0.2	
<i>n</i> = 21	44.1 ± 22.5	M, F	6	1.17	7867	-4.4 ± 0.4	-1.7 ± 0.3	
Saris et al, 2000 (78)								
<i>n</i> = 76	41.0 ± 9.0	M, F	24	1.06	10 400	-0.9 ± 0.4	0.3 ± 0.3	
<i>n</i> = 83	38.0 ± 9.0	M, F	24	1.12	9300	-1.8 ± 0.4	0.0 ± 0.3	
Sharman et al, 2004 (80)								
<i>n</i> = 15	33.2 ± 11.3	M	6	1.19	7770	-6.1 ± 0.8	NA	
Skov et al, 1999 (81)								
<i>n</i> = 25	39.8 ± 9.5	M, F	26	1.49	8950	-8.7 ± 0.7	-1.1	
Stimson et al., 2007								
<i>n</i> = 17	38	M	4	127.1	7339	-6.3 ± 2.2	NA	
<i>n</i> = 17	38	M	4	138.1	7984	-4.4 ± 2.6	NA	
<i>n</i> = 6	41	M	4	139.9	8081	-7.2 ± 2.3	NA	
<i>n</i> = 6	41	M	4	139.7	8537	-4.7 ± 1.0	NA	
Velthuis-te Wierik et al, 1994 (83)								
<i>n</i> = 8	43.0 ± 5.0	M	10	1.31	11 500	-2.7 ± 0.7	-0.3 ± 0.3	
<i>n</i> = 16	43.0 ± 4.0	M	10	1.17	9200	-7.4 ± 0.7	-0.7 ± 0.4	
Volek et al, 2002 (84)								

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Table 1. Summary of studies evaluating high protein diets on weight management

<i>n</i> = 12	36.7 ± 11.6	M	6	2.22	9770	-2.2 ± 0.5	1.1 ± 0.3
Volek et al, 2003 (85)							
<i>n</i> = 10	26.3 ± 6.1	F	4	2.14	7500	-1.2 ± 0.3	NA
Volek et al, 2004 (86)							
<i>n</i> = 13	34.0 ± 8.6	F	4	1.15	5410	-3.0 ± 0.4	NA
Walker et al, 1999 (88)5							
<i>n</i> = 21	58.0 ± 7.0	F	12	1.22	6200	-1.6 ± 0.4	-0.6
			12	1.08	6300	-0.9 ± 0.4	-0.5
Wang et al, 2005 (89)							
<i>n</i> = 39	54.2 ± 3.1	M	8	1.51	10 907	-1.1 ± 0.3	NA
Weigle et al, 2003 (90)							
<i>n</i> = 18	45.3 ± 13.6	M,F	12	1.31	8219	-3.8 ± 1.0	-0.1
Weigle et al, 2005 (91)							
<i>n</i> = 19	41.0 ± 11.0	M,F	12	2.06	8400	-4.9 ± 0.5	-1.2
Wood et al., 2007							
<i>n</i> = 30	30	M	12	110.0	6770	-74 ± 3.3	-1.4 ± 2.3
<i>n</i> = 30	30	M	12	109.2	6824	-7.5 ± 4.1	-1.4 ± 2.2
Yancy et al, 2004 (5)							
<i>n</i> = 45	45.3 ± 9.5	M,F	24	1.00	6140	-12.0 ± 0.9	-3.3 ± 0.3
Young et al, 1952 (94)							
<i>n</i> = 7	19.9 ± 0.9	F	8.5	1.22	5880	-7.7 ± 1.0	NA

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Table 1. Summary of studies evaluating high protein diets on weight management

Young et al, 1953 (95)								
<i>n</i> = 5	22.4 ± 5.1	F	10	1.15	5880	-9.0 ± 1.0	NA	
Young et al, 1957 (96)								
<i>n</i> = 8	22.0 ± 1.8	M	8.29	1.28	7560	-10.3 ± 0.8	NA	
Young et al, 1958 (97)								
<i>n</i> = 7	21.7 ± 1.6	M	8.86	1.27	7560	-13.8 ± 0.3	NA	
Young et al, 1960 (98)6								
<i>n</i> = 4	19.9 ± 0.9	F	4	1.06	10 080	-1.2 ± 0.1	NA	
<i>n</i> = 7	20.1 ± 0.9	F	10.57	1.17	5880	-9.3 ± 1.4	NA	
Young et al, 1960B (99)								
<i>n</i> = 5	21.0 ± 2.5	F	8.43	1.26	5880	-7.8 ± 0.6	NA	
Young et al, 1965 (100)								
<i>n</i> = 3	20.7 ± 2.1	F	12	1.27	5880	-6.6 ± 0.8	-0.8 ± 0.7	
<i>n</i> = 4	22.5 ± 1.3	M	12	1.28	7560	-13.8 ± 1.9	-2.9 ± 1.2	
Young et al, 1971 (101)								
<i>n</i> = 2	23.3 ± 1.8	M	9	1.17	7560	-11.2 ± 2.7	-2.8 ± 0.9	
<i>n</i> = 3	23.3 ± 1.8	M	9	1.2	7560	-12.3 ± 0.6	-2.0 ± 0.8	
<i>n</i> = 3	23.3 ± 1.8	M	9	1.1	7560	-14.0 ± 1.6	-0.8 ± 0.2	
Young et al, 1971B (102)7								
<i>n</i> = 3	22.2 ± 1.3	M	4–5	1.07	7560	-4.8 ± 0.9	NA	
<i>n</i> = 3	22.2 ± 1.3	M	4–5	1.13	7560	-4.9 ± 0.8	NA	

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Table 1. Summary of studies evaluating high protein diets on weight management

<i>n</i> = 4	22.2 ± 1.3	M	4–5	1.07	7560	-6.5 ± 1.0	NA
<i>n</i> = 4	22.2 ± 1.3	M	4–5	1.07	7560	-6.5 ± 0.6	NA
<i>n</i> = 4	22.2 ± 1.3	M	4–5	1.14	7560	-5.7 ± 0.4	NA
<i>n</i> = 4	22.2 ± 1.3	M	4–5	1.13	7560	-5.7 ± 0.9	NA
Zimmerman et al, 1984 (103)							
<i>n</i> = 7	34.5 ± 6.9	F	7	1.15	4200	-7.6 ± 1.4	NA

Values are $x \pm$ or $x \pm$ SEM. NA, not available.

Adapted from Krieger et al, 2006

*Additional data, published after Krieger, et al 2006 in **bold***

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