

Original Research

Effects of Whey Protein and Resistance Exercise on Body Composition: A Meta-Analysis of Randomized Controlled Trials

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Key words: whey protein, body composition, meta-analysis, randomized controlled trials, exercise

Objective: The objective of the present meta-analysis was to examine the effect of whey protein (WP), with or without resistance exercise, on body weight and body composition in randomized controlled trials (RCTs) in healthy adult study populations.

Design: Literature search was conducted to identify RCTs that investigated WP consumption and body weight, body mass index (BMI), body fat, lean body mass (LBM), fat-free mass, and fat-free mass. Random-effects meta-analyses were conducted to generate weighted group means for between-group comparisons (WP vs other protein sources or carbohydrates) and mean (i.e., differences from baseline to trial end). Studies were classified into 2 distinct meta-analyses: whey protein and resistance exercise (WP+RE) and whey protein as a replacement for other sources (WP+R). Subgroup analyses included examining the effect of type of WP on the relationship between WP and body composition.

Results: 73 studies included, with a total of 626 adult study completers. The studies examined the relationship between WP and body composition. The studies examined the effect of WP on body weight (WGMD: -4.20 kg, 95% CI: -7.67, -0.73) and body fat (WGMD: -5.74 kg, 95% CI: -5.98, -1.50) were statistically significant. Results from the subgroup analyses indicated a statistically significant relationship between WP and body composition.

Conclusion: The present meta-analysis supports the use of WP either as a supplement combined with resistance exercise or as a replacement for other protein sources in a diet to improve body composition parameters. However, the present meta-analysis did not evaluate the effect of WP on body composition in the context of overall dietary patterns, some individual food groups or other dietary constituents that have received considerable attention for their potentially favorable influence on safety, energy balance, body weight, and body composition (5-8). Dairy products are one such food group (9), however, findings from RCTs examining dairy products and body composition have been mixed. These inconsistent findings may be attributable to the heterogeneous nature of the dairy food group. Individual dairy foods contain variable levels of nutrients and other components, thus, considering dairy products as one single exposure is challenging by this heterogeneity. Examining specific constituents of dairy products may be important because it could



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AGENDA

- Background
- Objective
- Methodology
- Key Findings
- Conclusion
- Future Research Needs
- Resources

BACKGROUND

Background

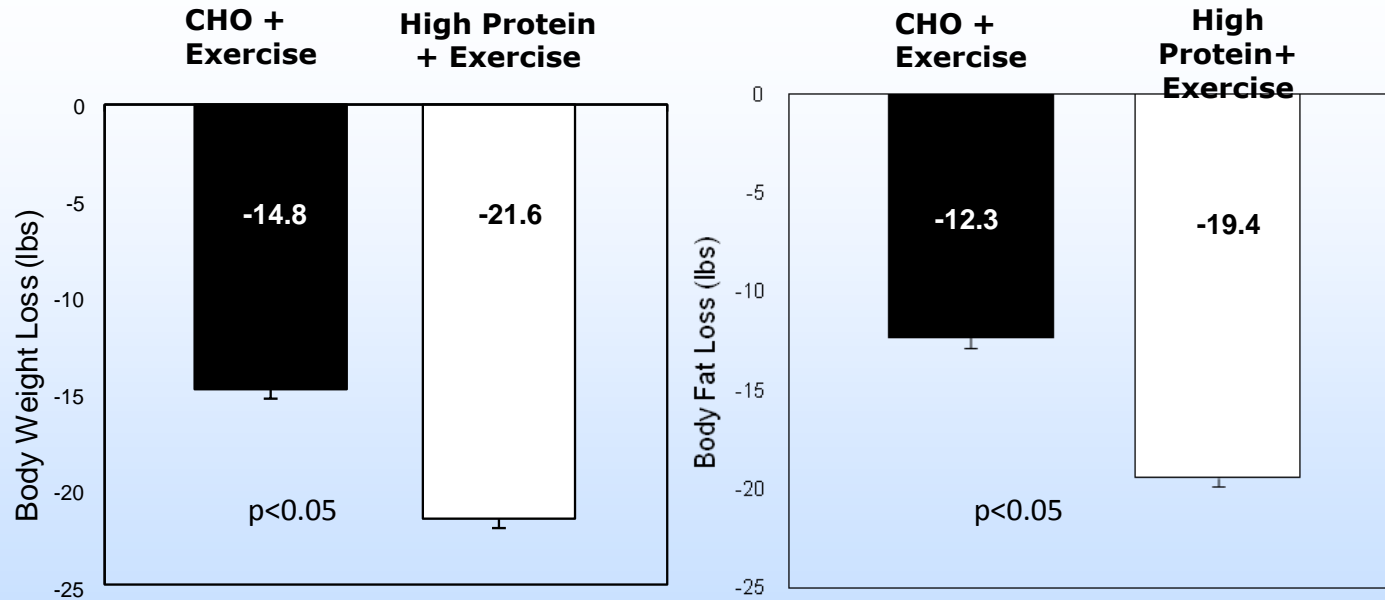
- A growing body of evidence has shown that diet composition, in addition to reduced calorie intake and increased physical activity, is a critical component of weight loss and weight maintenance¹⁻³.
- Recent findings have favored a higher protein, lower carbohydrate diet for weight loss^{2,3}.
- Higher protein diets appear beneficial for reducing fat mass as well as preserving lean body mass and resting energy expenditure³.

1. Noakes M, Reogh JB, Foster PR, Clifton PM: Effect of an energy-restricted, high-protein, low-fat diet relative to a conventional high-carbohydrate, low-fat diet on weight loss, body composition, nutritional status, and markers of cardiovascular health in obese women. *Am J Clin Nutr* 81: 1298-306, 2005.
2. Hession M, Rolland C, Kulkarni U, Wise A, Broom J: Systematic review of randomized controlled trials of low-carbohydrate vs. low-fat/low-calorie diets in the management of obesity and its comorbidities. *Obesity reviews: an official journal of the International Association for the Study of Obesity* 10:36-50, 2009.
3. Wycherley TP, Moran LJ, Clifton PM, Noakes M, Brinkworth GD: Effects of energy-restricted high-protein, low-fat compared with standard-protein, low-fat diets: a meta-analysis of randomized controlled trials. *Am J Clin Nutr* 96:1281-98, 2012.

High Protein Diets: Weight and Body Fat

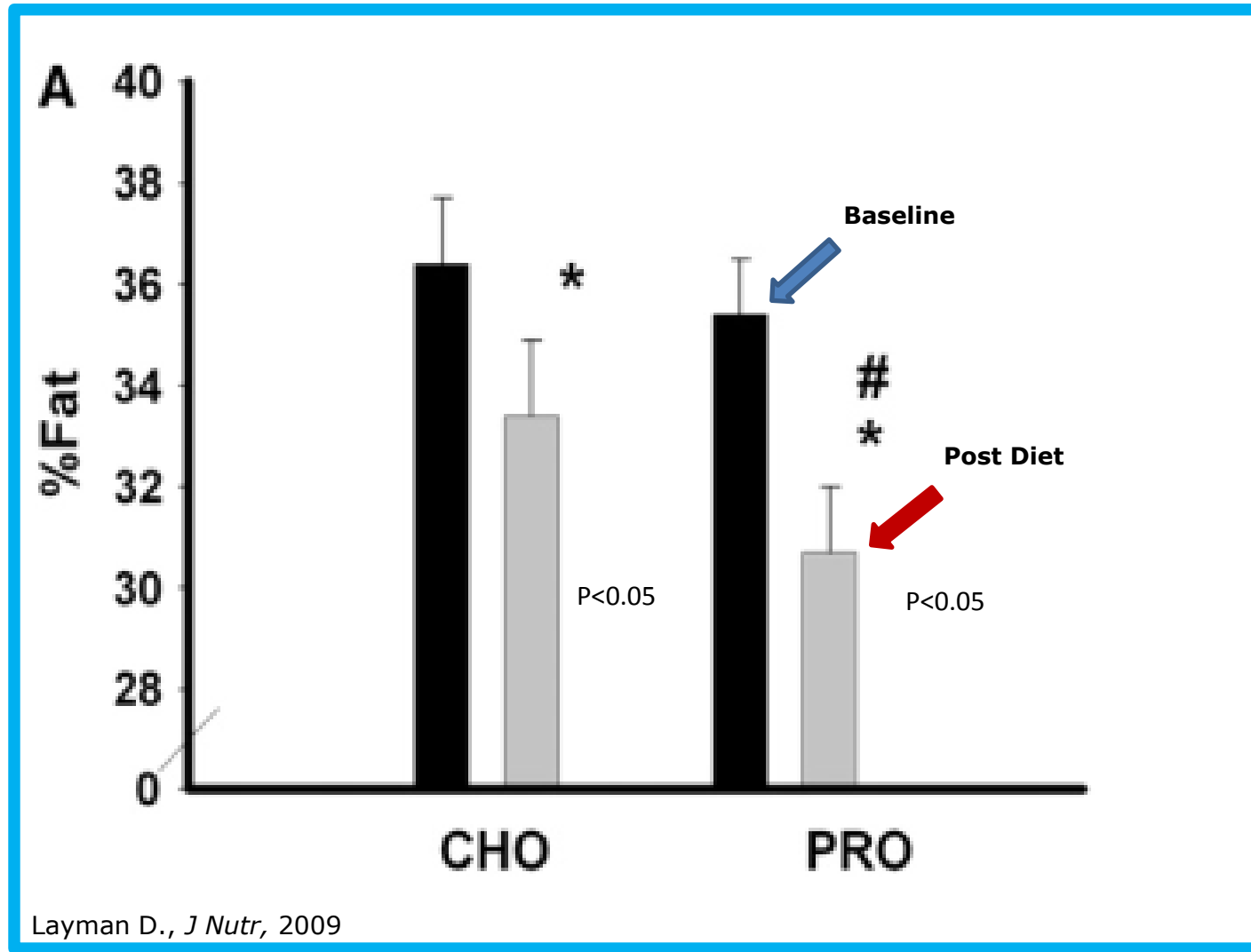
Author(s)	Title	Journal	Date/Vol/Issue/Pg
Josse AR, et al.	Diets higher in dairy foods and dietary protein support bone health during diet-and exercise-induced weight loss in overweight and obese premenopausal women	The Journal of Clinical Endocrinology and Metabolism	2012 Jan; 97(1):251-60
Mojtahedi MC, et al.	The effects of a higher protein intake during energy restriction on changes in body composition and physical function in older women	The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences.	2011; 66(11): 1218-25
Bortolotti M, et al.	Effects of a whey protein supplementation on intrahepatocellular lipids in obese female patients	Clinical Nutrition	2011; 30(4): 494-498
Josse AR, et al.	Increased consumption of dairy foods and protein during diet-and exercise-induced weight loss promotes fat mass loss and lean mass gain in overweight and obese premenopausal women	The Journal of Nutrition	2011; 141: 1626-1634
Baer DJ, et al.	Whey protein but not soy protein supplementation alters body weight and composition in free-living overweight and obese adults	The Journal of Nutrition	2011; 141(8): 1489-94
Soenen S et al.	Changes in body fat percentage during body weight stable conditions of increased daily protein intake vs. control	Physiology & Behavior	2010; 101: 635-638
Wycherley TP, et al.	A High Protein Diet With Resistance Exercise Training Improves Weight Loss And Body Composition In Overweight And Obese Patients With Type 2 Diabetes	Diabetes Care	2010
Layman DK, et al.	A Moderate-Protein Diet Produces Sustained Weight Loss and Long-Term Changes in Body Composition and Blood Lipids in Obese Adults	Journal of Nutrition	2009; 139(3):514-21
Layman DK, et al.	Dietary Protein and Exercise Have Additive Effects on Body Composition during Weight Loss in Adult Women	Journal of Nutrition	2005; 135: 1903–1910
Lejeune MP, et al.	Additional protein intake limits weight regain after weight loss in humans	British Journal of Nutrition	2005; 93(2):281-9
Luscombe-Marsh ND, et al.	Carbohydrate-restricted diets high in either monounsaturated fat or protein are equally effective at promoting fat loss and improving blood lipids	American Journal of Clinical Nutrition	2005; 81:762–72
Weigle DS, et al.	A high-protein diet induces sustained reductions in appetite, ad libitum caloric intake, and body weight despite compensatory changes in diurnal plasma leptin and ghrelin concentrations	American Journal of Clinical Nutrition	2005; 82:41-48
Westerterp-Plantenga MS, et al.	High protein intake sustains weight maintenance after body weight loss in humans	International Journal of Obesity Related Metabolic Disorders	2004; 28(1):57-64
Layman DK, et al.	A Reduced Ratio of Dietary Carbohydrate to Protein Improves Body Composition and Blood Lipid Profiles during Weight Loss in Adult Women	Journal of Nutrition	2003;133: 411–415

High Protein Diets: Weight and Body Fat

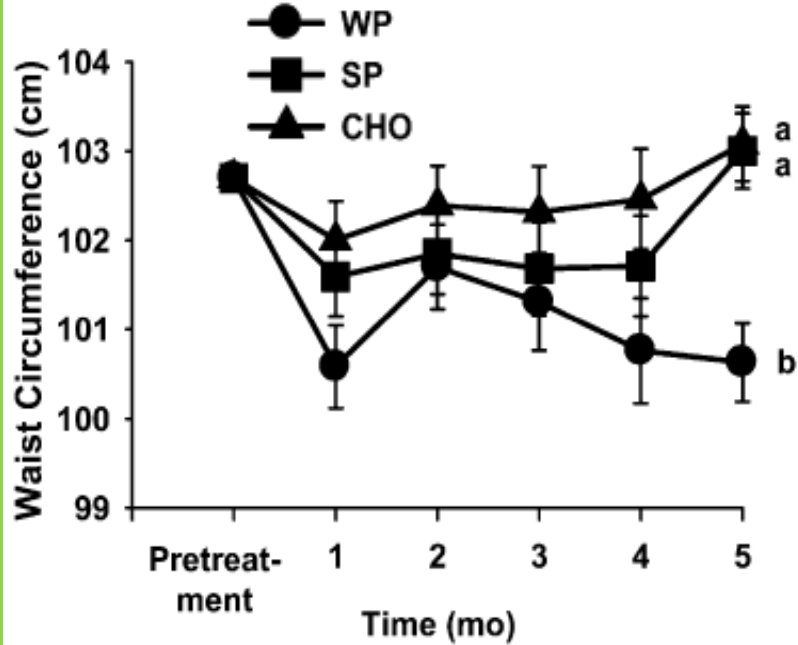


Layman D., *J Nutr*, 2005

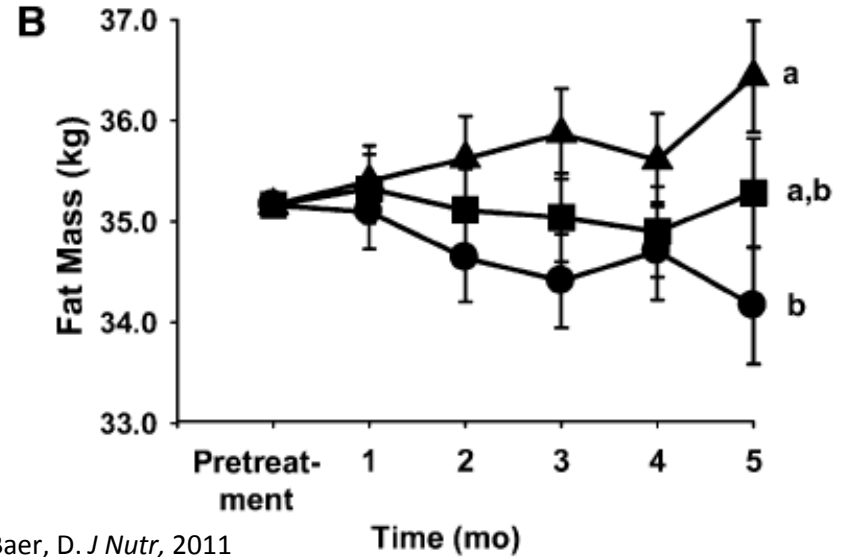
High Protein Diets: Body Fat



High Protein Diets: Waist Circumference and Body Fat Mass

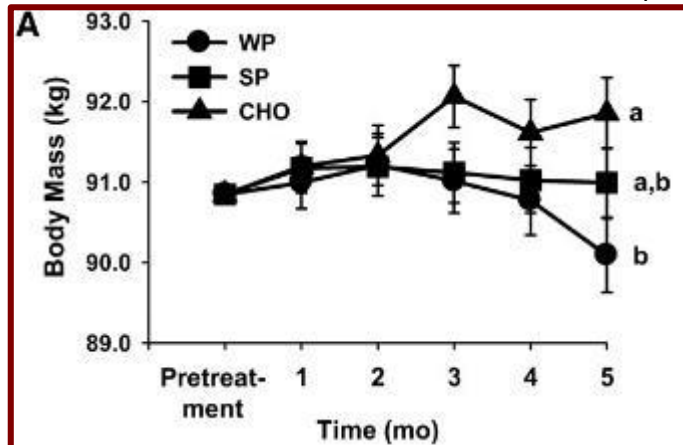


Baer, D. *J Nutr*, 2011



Baer, D. *J Nutr*, 2011

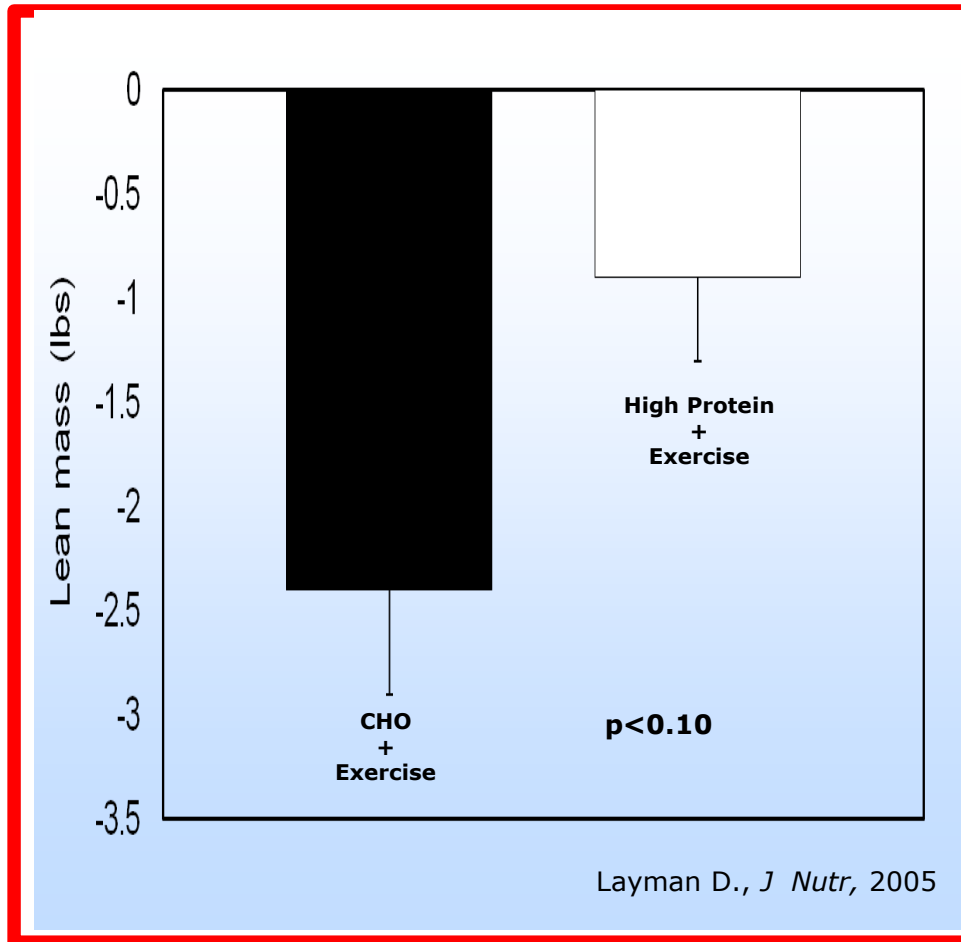
Means without a common letter differ at final measure, $p < 0.05$.



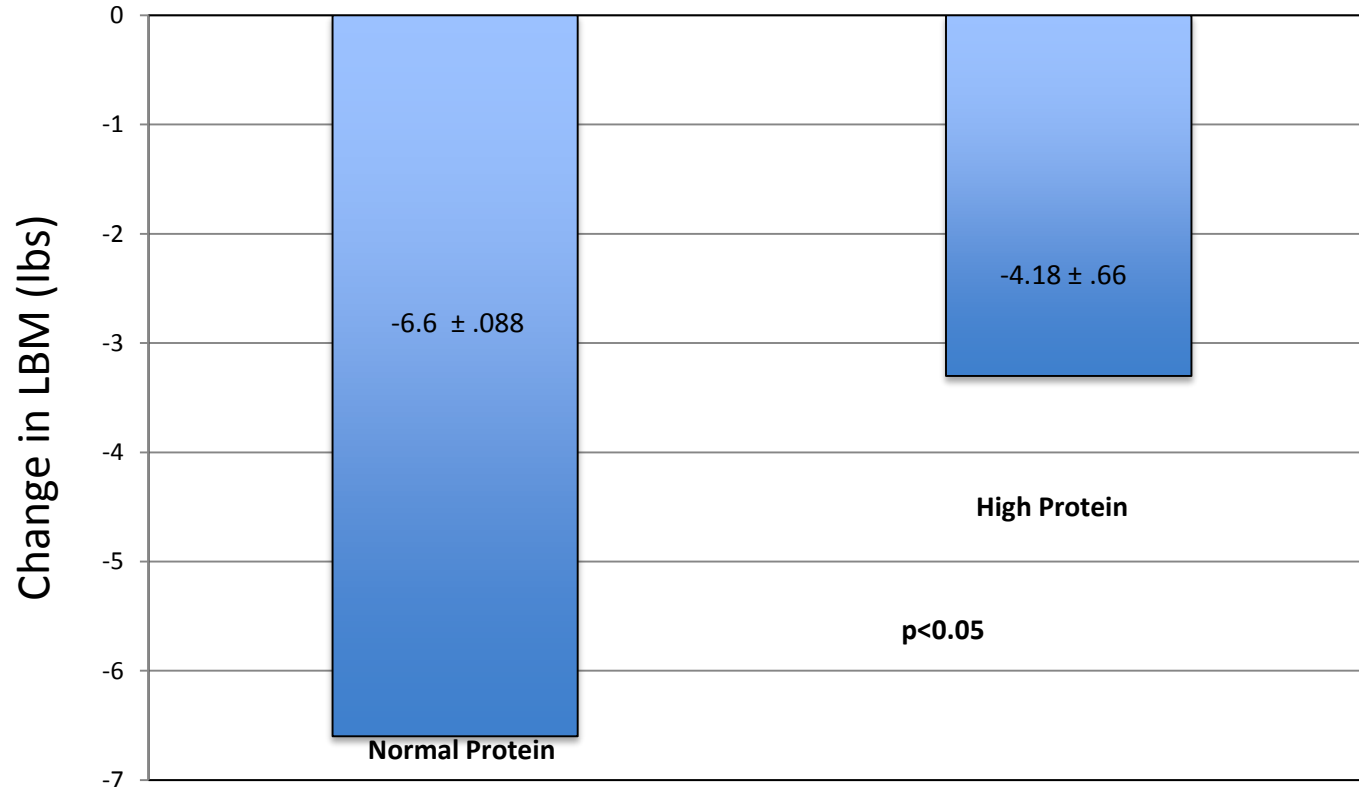
High Protein Diets: Lean Body Mass & Muscle

Author(s)	Title	Journal	Date/Vol/Issue/Pg
Leidy, et al.	Higher Protein Intake Preserves Lean Mass and Satiety with Weight Loss in Pre-obese and Obese Women	Obesity	2007 Feb; 15 (2): 421-429
Dideriksen KJ, et al.	Stimulation of muscle protein synthesis by whey and caseinate ingestion after resistance exercise in elderly individuals	Scandinavian Journal of Medicine & Science in Sports.	2011 Dec;21(6):e372-83
Rowlands DS, et al.	The transcriptome and translational signaling following endurance exercise in trained skeletal muscle: impact of dietary protein	Physiological Genomics.	2011; 43(17): 1004-20
Burd NA, et al.	Enhanced Amino Acid Sensitivity of Myofibrillar Protein Synthesis Persists for up to 24 h after Resistance Exercise in Young Men	The Journal of Nutrition	2011; 141(4): 568-573
Beelen M, et al.	Impact of protein coingestion on muscle protein synthesis during continuous endurance type exercise	American Journal of Physiology. Endocrinology and Metabolism	2011 Jun;300(6):E945-54.
Breen L, et al.	The influence of carbohydrate-protein co-ingestion following endurance exercise on myofibrillar and mitochondrial protein synthesis	The Journal of Physiology	2011; 589(16): 4011-25
Pasiakos SM, et al.	Leucine-enriched essential amino acid supplementation during moderate steady state exercise enhances post exercise muscle protein synthesis	The American Journal of Clinical Nutrition	2011; 94: 809-818
Beelen M, et al	Impact of protein coingestion on muscle protein synthesis during continuous endurance type exercise	American Journal of Physiology. Endocrinology and Metabolism	2011; 300(6): E945-E954
West DWD, et al.	Rapid aminoacidemia enhances myofibrillar protein synthesis and anabolic intramuscular signaling responses after resistance exercise	The American Journal of Clinical Nutrition	2011; 94: 795-803
G Coffey, et al.	Nutrient provision increases signaling and protein synthesis in human skeletal muscle after repeated sprints	European Journal of Applied Physiology	2011 Jul;111(7):1473-83
Burd NA, et al.	Muscle time under tension during resistance exercise stimulates differential muscle protein sub-fractional synthetic responses in men	J. Physiol.	2012;590(Pt 2):351-62
Soop M, et al.	Co-ingestion of whey protein and casein in a mixed meal—demonstration of a more sustained anabolic effect of casein	Am J Physiol Endocrinol Metab.	2012 Jul 1;303(1):E152-62.
Farnfield MM, et al	Activation of motor signaling in young and old human skeletal muscle in response to combined resistance exercise and whey protein ingestion	Appl Physiol Nutr Metab.	2012; 37(1): 21-30
Churchward-Venne TA, et al	Nutritional regulation of muscle protein synthesis with resistance exercise: strategies to enhance anabolism	Nutr Metab (Lond)	2012; 9(1): 40
Tang, M, et al.	Normal vs. High-Protein Weight Loss Diets in Men: Effects on Body Composition and Indices of Metabolic Syndrome	Obesity	2013; 21, E204-E210,

HIGH PROTEIN DIETS: LEAN BODY MASS & MUSCLE

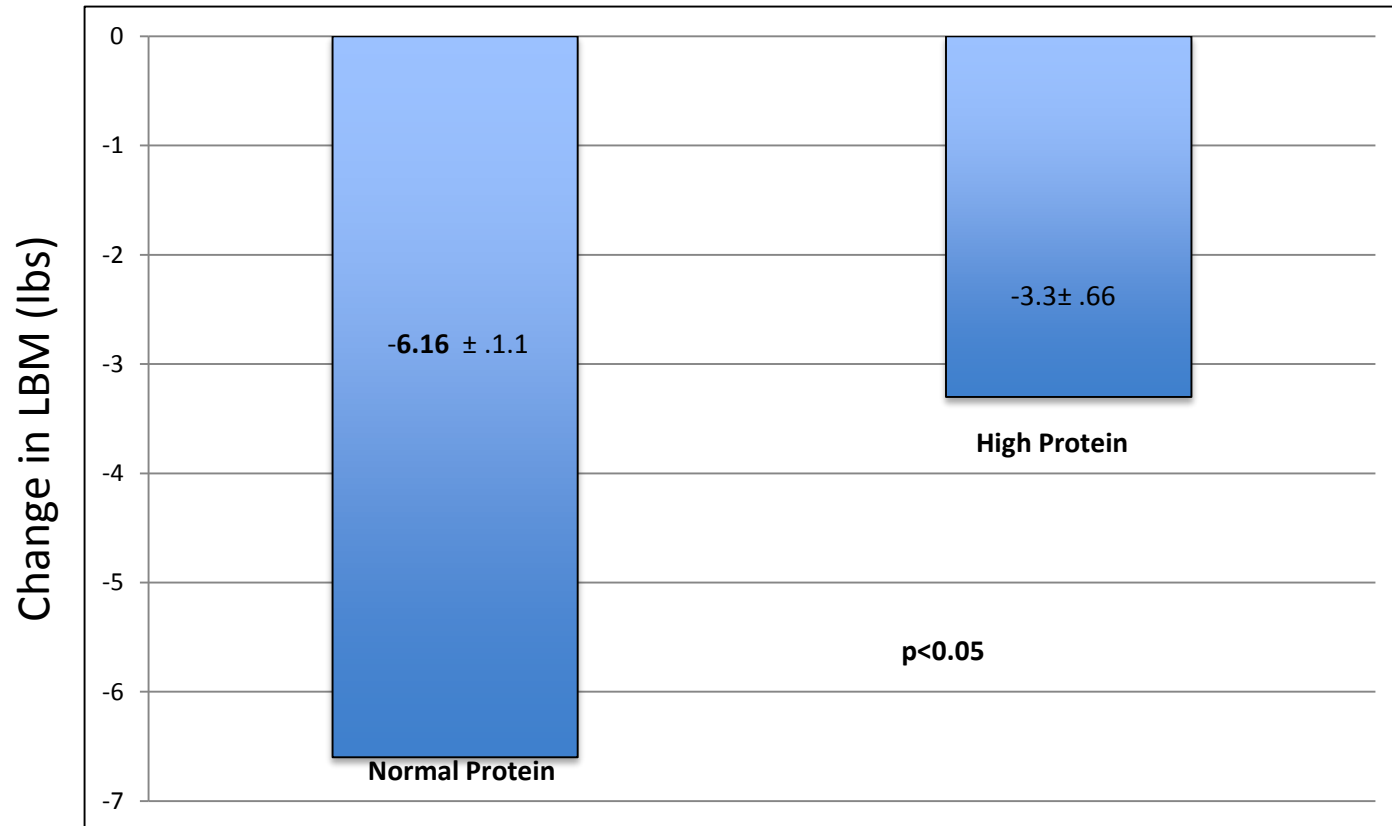


HIGH PROTEIN DIETS: LEAN BODY MASS & MUSCLE



Tang, M. *Obesity*, 2013

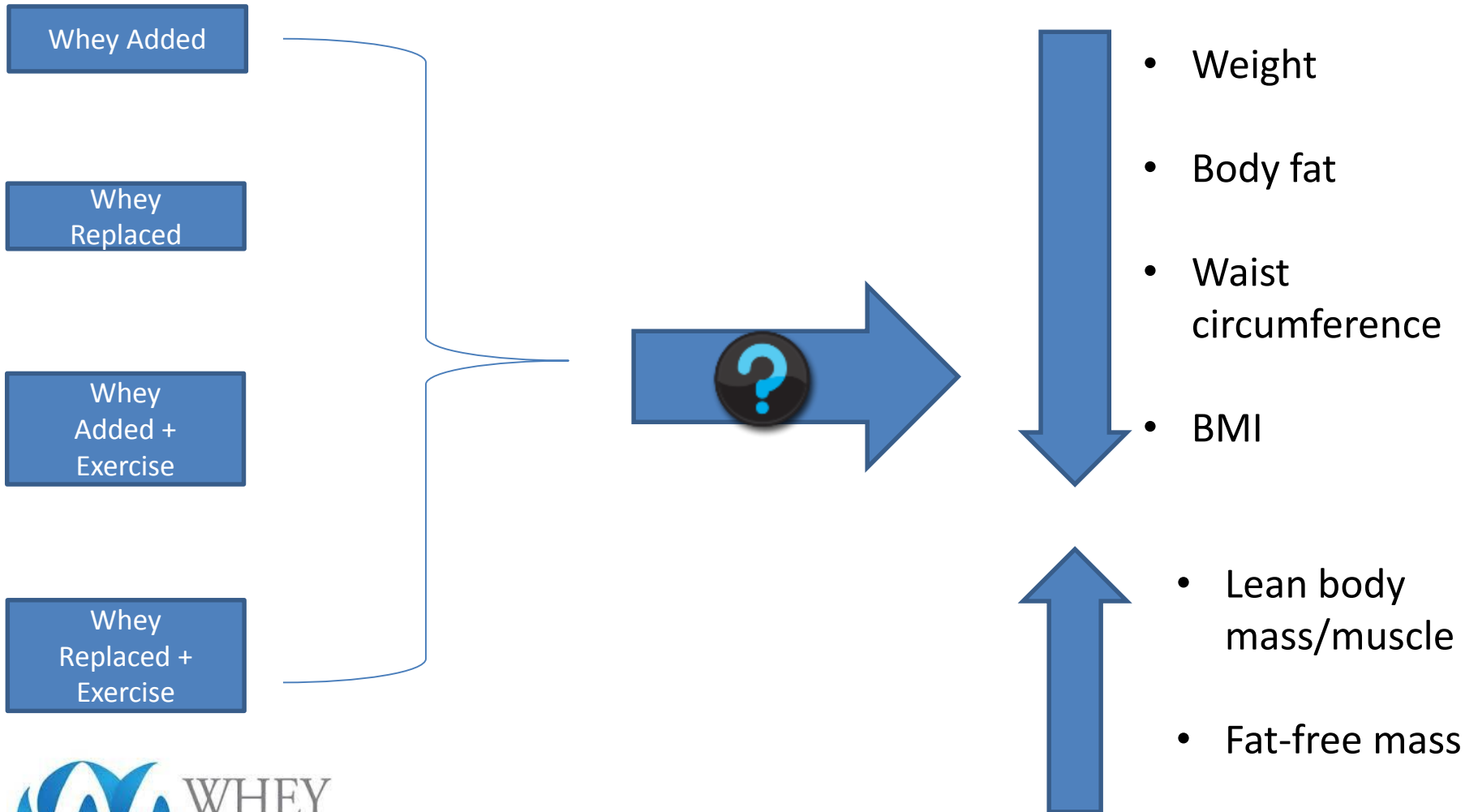
HIGH PROTEIN DIETS: LEAN BODY MASS & MUSCLE



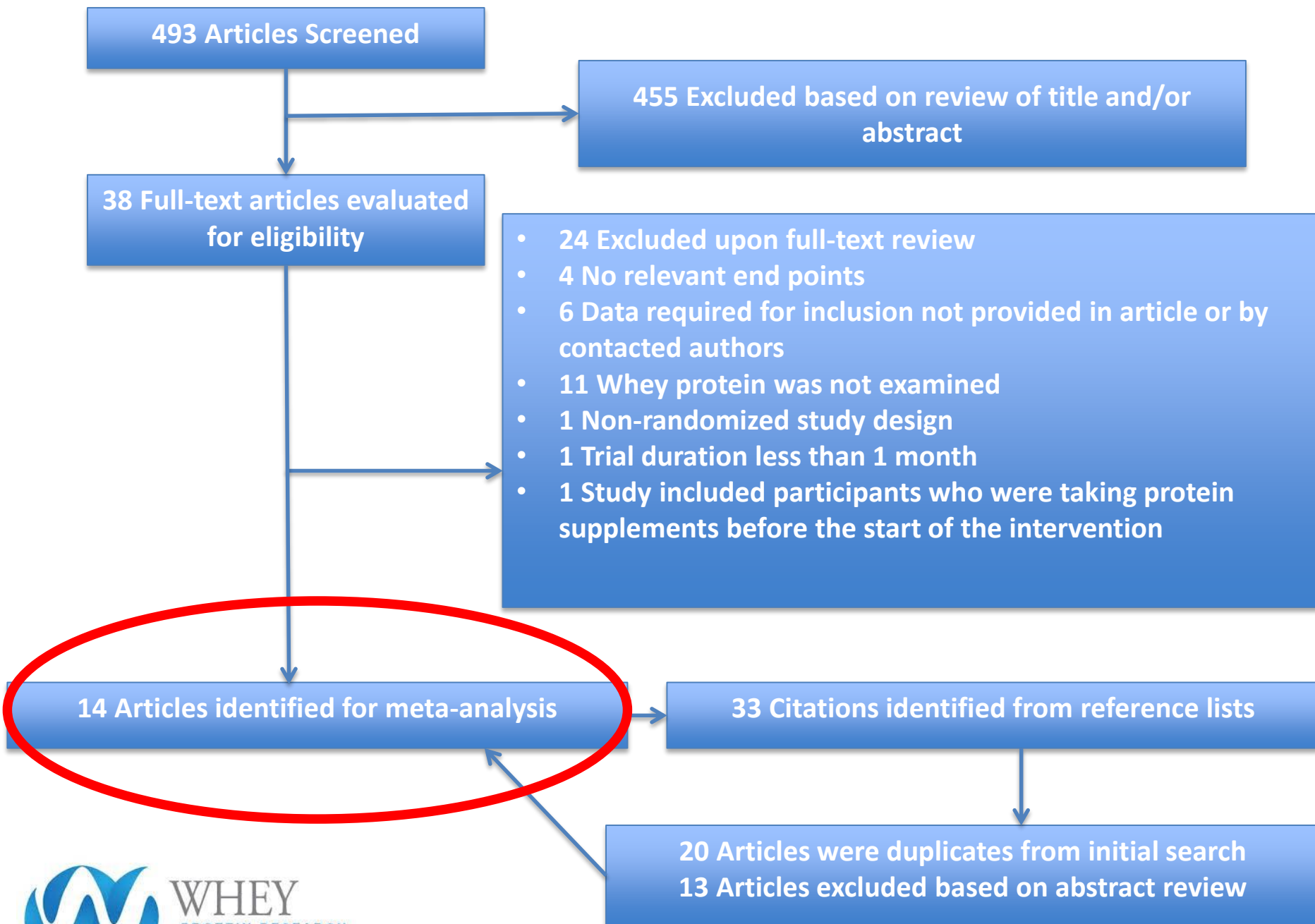
Leidy, H. *Obesity*, 2007

OBJECTIVE

Meta-Analysis Objective



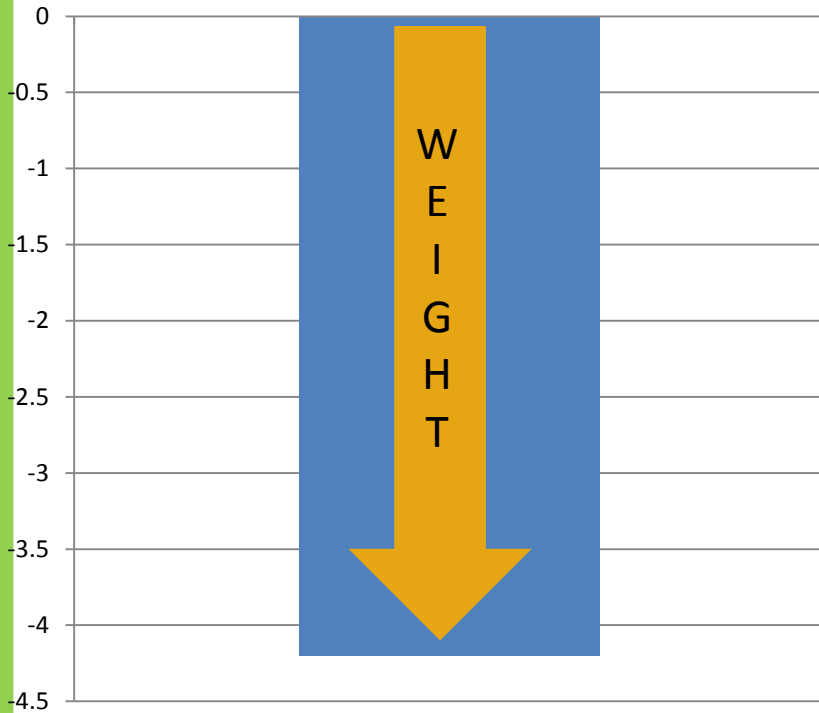
METHODOLOGY



RESULTS

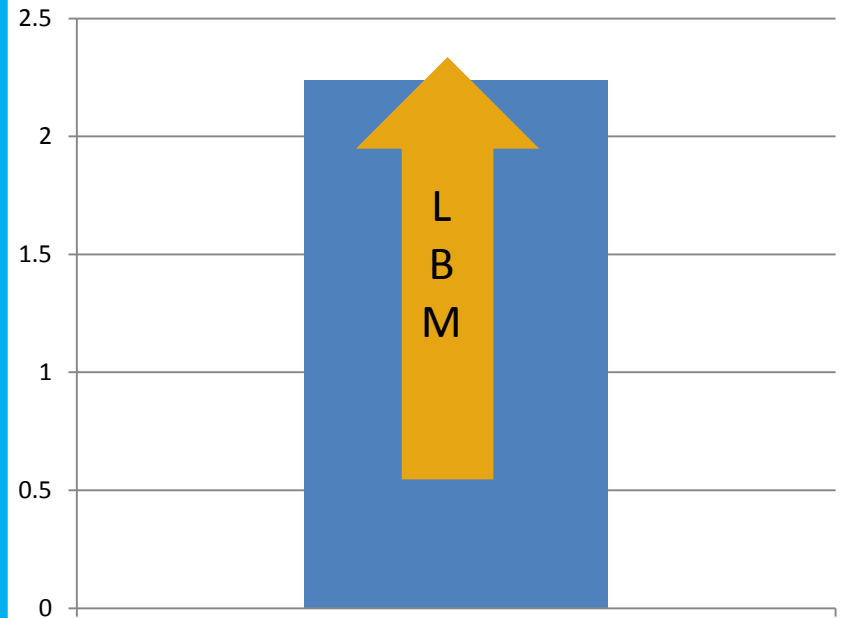
Results

Whey Protein Replacement: Body Weight Change 4.2 (kg) from Baseline to Trial End (5 studies)



95% CI: -7.67, -0.73

Whey Protein Provisions and Resistance Exercise: Lean Body Mass Change 2.24 (kg) from Baseline to Trial End (7 studies)



95% CI: 0.66, 3.81

On average, people lost 4.2 kg (9.2 lbs) from baseline to trial end when whey protein iso-calorically replaced another protein source or carbohydrate

CONCLUSION

Conclusion

- The authors concluded the current body of literature supports the use of whey protein to improve body composition, either as a supplement combined with resistance exercise or as part of a weight-loss or weight-maintenance diet.
- The beneficial effects of whey protein on body composition are most pronounced when consumed in concert with resistance exercise and an overall healthy diet that compensates for the additional calories from supplementation.

Future Research Needs

- Studies designed to examine the effects of whey protein by relevant demographic characteristics to determine the optimal dosage, trial duration and type and frequency of resistance exercise
- Longer-term (at least one year) randomized controlled trials with whey protein supplementation, calorie compensation and resistance exercise

Educational Resources

visit <http://www.wheyconsortium.org/meta-analysis> for more information



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[USDairy.com](#)
[Whey Protein Institute](#)
[Whey Publications by US Dairy Export Council](#)



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Recent Events

The Whey to Help Achieve a Better Body Composition

This toolkit was designed to help health and fitness professionals, scientists and researchers learn about and educate their clients and patients about the effects of whey protein on body composition and weight management. The toolkit is comprised of several educational tools and resources that highlight findings from the recently published meta-analysis as well as the growing body of research on the benefits of whey protein, as part of a higher protein diet.

Key Findings Fact Sheet
- This document highlights the key findings of the meta-analysis and provides a quick overview of the study results.

Whey Protein Brochure
- This brochure, designed specifically for clients and patients, helps tell the story behind the growing body of research on whey protein, as part of a diet higher in protein, and its effects on body weight and body composition.

Whey Protein Tips/Fact Sheet
- This fact sheet provides a quick, at-a-glance overview of the benefits of whey protein and shows how clients and patients can incorporate whey protein into their diets and healthy lifestyles.

PowerPoint - This tutorial PowerPoint presentation, complete with suggested talking points, discusses the meta-analysis in detail and provides an in-depth look at the growing body of research surrounding the effects of whey protein, as part of a diet higher in protein, on body weight and composition.

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Abstract

Objectives: The objective of the present meta-analysis was to examine the effect of whey protein (WP), with or without resistance exercise, on body weight and body composition in randomized controlled trials (RCTs) conducted in generally healthy adult study populations.

Methods: A comprehensive literature search was conducted to identify RCTs that investigated WP (concentrate, isolate, or hydrolyzate) and body weight, body mass index (BMI), body fat, lean body mass (LBM), fat-free mass (FFM), and waist circumference. Random effects meta-analyses were conducted to generate weighted group mean differences (WGMD) for between group comparisons (WP vs. other protein sources or carbohydrates) and within-WP group comparisons (i.e., differences from baseline to trial end). Studies were classified into two distinct groups—WP as a supplement without dietary modification (WPS) and WP as a replacement for other sources of calories (WPR)—and were meta-analyzed separately. Subgroup analyses included examining the effect of resistance exercise and type of WP on the relationship between WP and body composition.

Results: Fourteen RCTs were included, with a total of 626 adult study completers. Five studies examined the effects of WPR whereas the remaining nine studies examined the effects of WPS. Body weight (WGMD: -4.20kg, 95% CI: -7.67, -0.73) and body fat (WGMD: -3.74kg, 95% CI: -5.98, -1.50) were significantly decreased from baseline in the WPR within-group analyses. In the between-group analyses, the effects of WP were more favorable when compared with carbohydrates than protein sources other than whey, although findings did not reach statistical significance. Results from the subgroup analyses indicated a statistically significant increase in LBM (WGMD: 2.24 kg, 95% CI: 0.66, 3.81) among studies that included a resistance exercise component along with WP provision.

Toolkit: Whey Protein Fact Sheet

WHEY FACT SHEET

The Whey to Improved Body Composition and Weight

As science continues to support the role of protein in building and maintaining lean muscle, maintaining weight and healthy aging, consumers are embracing the important role of protein in the diet. But not all proteins are created equal and it turns out that protein quality has an important role when it comes to body composition and managing a healthy weight.

Whey protein is a high-quality protein naturally found in dairy. It is a complete protein containing all the essential amino acids ("building blocks") your body needs and is rapidly digestible. Whey protein is also one of the best sources of a subgroup of three essential amino acids, called branched-chain amino acids (BCAAs), which include leucine, isoleucine and valine. Unlike other amino acids, BCAAs are almost exclusively taken up and used by muscle. And, among common food sources of BCAAs, whey protein contains one of the highest levels of leucine, which has been shown to influence muscle growth.

BODY COMPOSITION

A recent meta-analysis shows that consumption of whey protein when combined with resistance exercise training is an effective strategy that aids in building valuable lean body mass in adults¹.

- Whey protein is naturally rich in leucine, an essential amino acid that stimulates cellular pathways leading to increased muscle protein synthesis².
- Consuming whey protein after exercise can enhance the rebuilding of muscle following exercise via enhanced muscle protein synthesis³.
- Consuming whey protein in combination with resistance exercise can boost the rate at which the body synthesizes lean muscle, which may improve body composition^{4,5}.

WEIGHT MANAGEMENT

High-quality protein, such as whey, may aid in weight maintenance by promoting satiety and improving body composition⁶.

- Increasing the amount of protein in the diet can lead to decreased total caloric intake and body weight⁷.
- Consuming meals higher in protein may help people eat fewer calories at subsequent meals⁸.
- Whey protein, as part of a diet higher in protein, may help provide a feeling of fullness more than carbohydrate or fat⁹.
- A reduced calorie, higher protein diet including whey protein may help in weight management. After a period of weight loss, diets high in protein preserve lean body mass, including muscle, during weight maintenance^{10,11}.

ADDING WHEY PROTEIN TO THE DIET IS EASY:

Whey protein can be found in many energy bars and drink mixes, and is now available in some yogurts. Look for "whey protein" (distillate, concentrate, or hydrolyzed) near the beginning of the ingredient list. **Whey Protein Powder**, which is available in a variety of flavors, is a fast and easy way to add high quality protein for favorite foods.

- Add 1/2 - 1 scoop of whey protein powder to milk, yogurt, pudding, oatmeal, milkshakes, smoothies, or cocoa.
- Add 2 or more scoops of whey protein powder to bread, cookie, pancake and muffin mixes or soups, chili, mashed potatoes, pasta, eggs, meatloaf, gravies, and sauces.

FOR MORE INFORMATION, CONTACT:

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- Created for consumers
- Highlights nutritional benefits
- Includes general information on whey intake

The logo features a stylized blue 'W' icon to the left of the text 'WHEY PROTEIN RESEARCH CONSORTIUM' in a bold, sans-serif font.

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Toolkit: Meta-Analysis Key Findings

META-ANALYSIS KEY FINDINGS

**The Effects of Whey Protein on Body Composition:
A Meta-Analysis of Randomized Controlled Trials**

A meta-analysis¹ published in the March/April 2014 issue of the *Journal of the American College of Nutrition* adds further evidence to the growing body of literature supporting the benefits of whey protein for weight maintenance and lean body mass. Through a comprehensive literature search, study authors examined the effect of whey protein—either as an addition to the diet or replacement for other calories coming from different protein sources or carbohydrates—with or without resistance exercise, on body weight and body composition in randomized controlled trials conducted in generally healthy adult study populations.

The authors concluded that the current body of literature supports the use of whey protein to improve body composition as a supplement combined with resistance exercise in weight-loss or weight-maintenance diet. The best whey protein on body composition are most probably consumed along with resistance exercise and an amount that compensates for the additional calories from other sources of calories.

KEY FINDINGS

- Fourteen randomized control trials were included as part of the meta-analysis, with a total of 626 adult participants
 - Five studies examined the effects of whey protein as a replacement for other sources of calories
 - Nine studies examined the effects of whey protein as a supplement
- Collectively, the evidence from randomized controlled trials indicates a modest beneficial effect of whey protein on body weight loss or weight-maintenance diet.

WHY PROTEIN AS A REPLACEMENT FOR OTHER SOURCES OF CALORIES

- When the effects of whey protein, particularly as a dietary replacement, on body weight and composition were evaluated, statistically significant decreases in body weight and body fat were observed, indicating the possible importance of utilizing whey protein as part of a meal replacement program.
- Body weight significantly decreased 4.2 kg (9.2 lbs) from baseline to trial end when whey protein iso-calorically replaced another protein source or carbohydrate.
- Body fat significantly decreased 3.74 kg (8.2 lbs) from baseline to trial end when whey protein iso-calorically replaced another protein source or carbohydrate.



WHY PROTEIN AS A SUPPLEMENT

- When the effects of resistance exercise plus whey protein as a supplement added to the diet were evaluated, statistically significant increases in lean body mass were observed, indicating the possible importance of utilizing whey protein as part of an exercise regimen.
- Lean body mass significantly increased by 2.24 kg (4.9 lbs), on average, among studies that included a resistance exercise component along with whey protein provision.

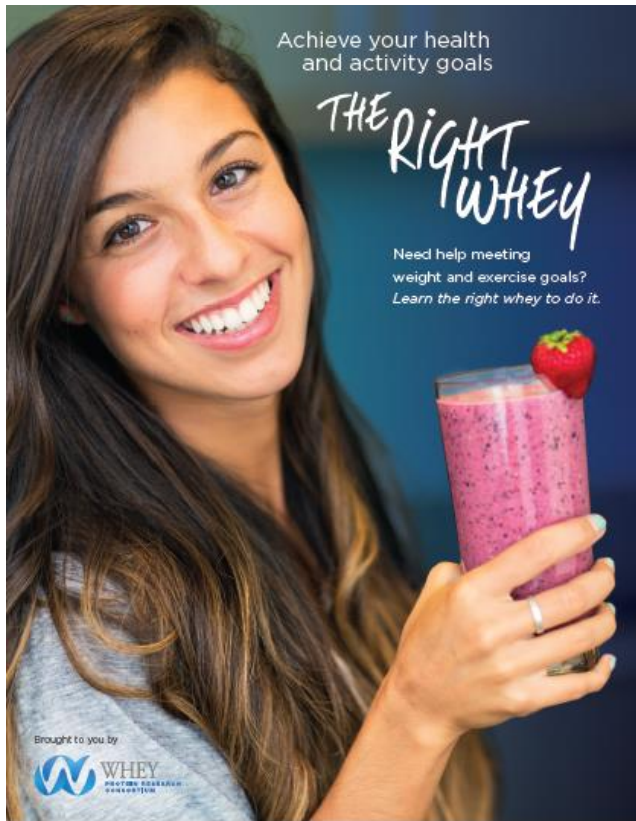
¹ Miller FC, Alexander DD, Pines V. Effects of Whey Protein on Body Composition: A Meta-Analysis of Randomized Controlled Trials. *Am J Clin Nutr*. 2014; 99(3): 683-678.

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- Created for health professionals
- Summarizes key findings from meta-analysis
- Includes study background, methodology and outcomes

Toolkit: Whey Protein Brochure



- Created for consumers
- Highlights benefits of whey protein
- Includes tips on incorporating whey into diet & lifestyle

Toolkit: Advertorial

Now available for free download...



The Effects of Whey Protein on Body Composition: A Meta-Analysis of Randomized Controlled Trials

A meta-analysis published in the March/April 2014 issue of the *Journal of the American College of Nutrition* titled, "The Effects of Whey Protein on Body Composition: A Meta-Analysis of Randomized Controlled Trials" adds further evidence to the body of literature supporting the use of whey protein as part of a diet higher in protein to improve body composition and maintain weight, either as a supplement combined with resistance exercise or as part of a weight-loss or weight-maintenance diet.

Visit www.wheyconsortium.org/meta-analysis.com for more information about this and other research, as well as educational resources highlighting the growing body of research on the benefits of whey protein.

Check It out to find:

- Key Findings.** The Key Findings document highlights the key findings of the meta-analysis to provide a quick overview of the results from the meta-analysis.
- Whey Protein Brochure.** This brochure is designed specifically for clients and patients, will help tell the story behind the growing body of research on whey protein as part of a diet higher in protein and its effects on body weight and body composition.
- Turnkey PowerPoint.** The Turnkey PowerPoint presentation, complete with suggested talking points, discusses the meta-analysis in detail and provide an in-depth look at the growing body of research surrounding the effects of whey protein as part of a diet higher in protein on body weight and composition.
- Whey Protein Fact Sheet.** This fact sheet provides a quick, at-a-glance overview of the benefits of whey protein and how clients and patients can incorporate whey protein into their diets and healthy

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FOR MORE INFORMATION, VISIT:
www.wheyconsortium.org/meta-analysis

- Created for health professionals
- Highlights contents of WPRC educational toolkit

Additional Resources

Whey Protein Research Consortium Members:

<http://www.wheyconsortium.org/Pages/Home.aspx>

- **Agrimark**
<http://www.agrimark.coop/>
- **American Dairy Products Institute**
<http://www.adpi.org/>
- **Arla Foods**
<http://www.arlafoodsusa.com/>
- **Dairy Research Institute**
<http://www.usdairy.com/DairyResearchInstitute/Pages/DRI-Refresh.aspx>
- **Danone**
<http://www.danone.com/?lang=en>
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- **Davisco Foods**
<http://www.daviscofoods.com/>
- **Foremost Farms**
<http://www.foremostfarms.com/>
- **Glanbia Nutritionals**
<http://glanbianutritionals.com/>
- **Hilmar Ingredients**
<http://www.hilmaringredients.com/home/>
- **Midwest Dairy Association**
<http://www.midwestdairy.com/>
- **The Hershey Company**
<http://www.thehersheycompany.com/>
- **U.S. Dairy Export Council**
<http://www.usdec.org/home.cfm?navItemNumber=82205>
- **Volac International**
<http://www.volac.com/>
- **Wisconsin Milk Marketing Board**
<http://www.eatwisconsincheese.com/>