BODY COMPOSITION

THE BENEFITS OF WHEY PROTEIN

EDITED BY:
DOUGLAS B. DIRIENZO, PH.D.
QUADRANT NUTRITION, LLC

REVIEW UPDATE BY:
VICTOR L. FULGONI, PH.D.[1] &
YANNI PAPANIKOLAOU, M.HSC.[2]

[1]NUTRITION IMPACT LLC;
[2]NUTRITIONAL STRATEGIES INC.

Body Composition is Important in Health

Body composition is the relative proportion of body fat and fat-free mass (organs, bone and muscle tissue) that makes up the human body. An individual's body composition can have a profound influence on health and longevity.[1] With advancing age, people increase adiposity and lose fat-free mass, mostly in the form of muscle.[2] Studies now confirm that these undesirable changes in body composition have severe, long-term consequences to health.[3] A high level of body fat (often linked to being overweight) is directly associated with a much higher risk of heart disease, stroke, type 2 diabetes mellitus and other conditions that may reduce the lifespan.[4,5] Relative to normal weight, obesity is associated with significantly higher all-cause mortality.[6] Researchers have also suggested that by avoiding weight gain and maintaining a BMI between (22.5-25kg/m2), the average person in middle age would gain about two years of life expectancy. By avoiding the weight gain earlier in life, a young adult could expect to gain an average of three additional years of life.[7] Furthermore, obesity is associated with a lower quality of life, such that obese men and women are expected to have an increased number of unhealthy life-years due to work disability, coronary heart disease and the need for chronic medication.[8] Recent work has even shown that obese adults are likely to spend more days in hospital relative to non-obese individuals.[9]

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The Critical Importance of Muscle Mass Maintenance

Muscles are a dynamic reservoir of proteins that are constantly broken down and regenerated to meet all the structural and metabolic demands of the body.[10] Muscle is also the metabolic furnace that burns fat for fuel and drives the metabolism.[11] Metabolic rate is simply the rate at which the body burns energy; an individual's metabolism ultimately determines his or her body composition.[12] The controlled process of breakdown and synthesis of muscle proteins diminishes with aging and muscle mass decreases.[13] Additionally, the body's ability to utilize fat for fuel also decreases. The result is a slower metabolic rate that predisposes the older adult to further muscle loss and unwanted fat gain.[3]

Increased protein synthesis within muscle cells is vital to creating net gains in muscle protein and subsequent improvements in body composition.[22]

However, research now shows that the age-related decline in metabolic rate and increase in body fat accumulation is related specifically to a decrease in muscle mass and not aging per se.[2,12] For an individual in his 20's, muscle comprises up to 60% of the fat-free mass, when one reaches 70, this drops to less than 40%.[14] By preserving or increasing muscle mass, older adults can help protect themselves against undesirable changes in body composition as well as many ailments that are usually associated with aging.[1,4,12] In fact, some evidence suggests that the decline in resting metabolism and increase in body fat accumulation that occurs with age may be eliminated if muscle mass is maintained.[12] Striving to build and/or preserve muscle not only leads to a better body composition (less body fat and more fat-free mass); it also increases the chance of a longer, healthier life.[3,4]

Body Composition and Exercise

Although regular aerobic exercise, such as walking, jogging or cycling, provides a great way to burn energy and increase fitness, these activities do not provide an adequate stimulus to maintain muscle mass.[15] More than any other activity, resistance training exercise (using free weight devices) stimulates muscle protein synthesis to promote increases in strength and muscle mass that ultimately lead to an improved body composition.[16,17] The effectiveness of resistance training for improving body composition has been demonstrated in a variety of populations, including healthy adults, elderly and those with chronic conditions such as type 2 diabetes.[15,16,18,19] Even frail adults in their 90's respond robustly to intense resistance training programs with significant increases in strength, muscle size and anabolic hormone concentrations.[20]

Whey—An Effective Protein For Improving Body Composition

Researchers have confirmed that protein supplementation enhances the results that are desired from resistance training.[21] However, a review of the scientific literature reveals that protein sources are not all the same in terms of the benefits they may contribute to health and body composition. An increasing amount of scientific evidence indicates that whey proteins are tailored to promote a better body composition, particularly when combined with resistance exercise.

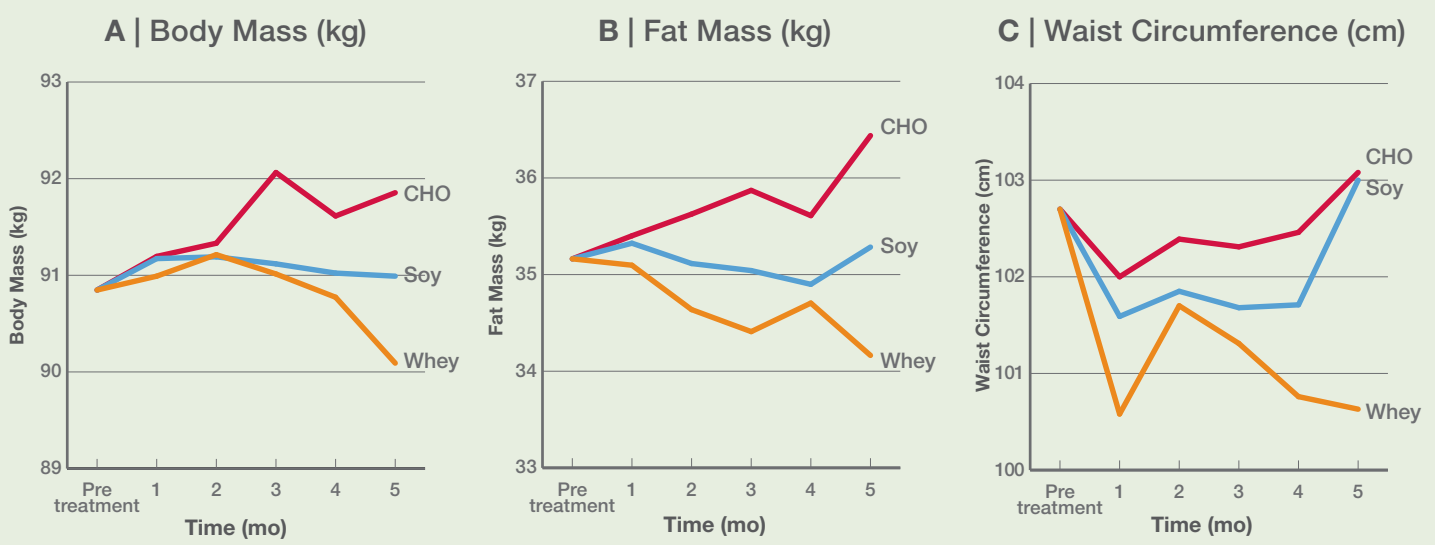
The biochemical rationale behind whey's effectiveness in preserving muscle mass and enhancing the results of resistance training is sound. Stimulating protein synthesis and minimizing protein breakdown are essential to recovery and muscle hypertrophy.[22] Increased protein synthesis within muscle cells is vital to creating net gains in muscle protein and subsequent improvements in body composition.[22]

The ability of a protein to stimulate muscle protein synthesis resides in

Sarcopenia

Sarcopenia is the loss of muscle that happens with aging.[14] Although sarcopenia is a common occurrence among apparently healthy older adults, new research suggests that this phenomenon initiates many of the undesirable conditions that are associated with aging, such as immobility, osteoporosis, diabetes, unwanted weight gain and increased susceptibility to illness.[10,14,30] The estimated, direct healthcare cost attributable to sarcopenia each year in the United States is $18.5 billion.[31] For more information on the role of muscle in the elderly population, please see the USDEC monograph on sarcopenia.

Figure A: Effect of supplemental carbohydrate (CHO), whey protein (WP), and soy protein (SP) on body mass (A), fat mass (B), and waist circumference (C) in overweight or obese adult men and women (n=73).[a]



[a]Data from Baer, Stote, Paul[37]

the amount and composition of amino acids.[21] Whey proteins are particularly effective at stimulating muscle protein synthesis for a number of reasons.

- Whey's amino acid profile is almost identical to that of skeletal muscle. Whey provides all the correct amino acids in approximate proportion to their ratios in skeletal muscle.[21]
- Compared to other protein sources, whey proteins contain a higher proportion (per 100g) of the essential amino acids (those that cannot be synthesized by the body).[23] The essential amino acids are shown to be the most effective at stimulating protein synthesis in adult muscle.[24]
- Whey is nature's richest source of branched chain amino acids.[25] Whey's amino acid composition is 26% branched chain amino acids and 6% glutamate.[23] The high concentration of the branched chain amino acids and in particular, leucine found in whey is of interest to exercise scientists. Several researchers suggest that an abundant supply of leucine to muscle after exercise may promote more efficient recovery at the cellular level to speed the adaptation process of exercise training.[26,27]

Additional research demonstrates that whey's beneficial effects on muscle may not reside exclusively in its amino acid profile. Scientists have now confirmed that blood amino acid concentrations control muscle protein synthesis and the ability to gain muscle from resistance training.[22] A high level of amino acids in the blood is necessary to stimulate muscle protein synthesis and maximize the stimulus of resistance training.[28] Unlike other high quality protein sources, whey is rapidly absorbed and provides a significant increase in blood amino acid concentrations to stimulate muscle protein synthesis.[29] Additionally, when whey is consumed as part of a mixed macronutrient meal, a strong and persistent inhibition of muscle breakdown is observed along with increased muscle protein synthesis.[29] On an equal serving basis, whey supplementation results in higher protein balance and greater muscle protein gain compared to other high quality proteins such as casein.[29] For all these reasons, whey protein supplementation seems to fit the ideal dietary prescription for building muscle and limiting muscle loss during aging.

Whey Protein Favorably Impacts Body Weight And Fat Loss

Whey protein's beneficial effects on body composition may not pertain exclusively to building muscle. Dairy products that are rich in calcium and dairy protein can play a role in the regulation of energy metabolism and whether an individual gains or loses body fat.[32] Diets that are rich in calcium may help prevent fat gain as well as increase fat metabolism, thereby accelerating the process of losing unhealthy body weight.[33] A review of the literature shows that calcium coming from dairy products appears to provide the greatest fat loss effect of all calcium sources.[34] Even without calorie restriction, increasing the intake of dairy products has been shown to reduce body fat and increase fat-free mass.[35] However, the beneficial impact of dairy foods on weight/fat loss is more consistent when combined with caloric restriction.[36] Although the bioactive

constituents responsible for dairy's beneficial effects on fat metabolism remain the subject of speculation, the researchers behind these studies suggest that whey proteins are a major contributor.[32,33,35]

Researchers at the U.S. Department of Agriculture recently compared the effects of whey protein against soy protein and carbohydrate feeding on body weight and composition for six months in overweight and obese adults without any daily energy restriction.[37] At the end of the study, body weight in the adults consuming whey protein was 1.8kg (~4lbs.) lower when compared to adults consuming carbohydrate (see Figure A). When comparing the two protein study groups, adults consuming whey protein had a 0.9kg (~2lbs.) lower body weight, but there were no significant differences between the two protein groups. Body fat mass was 2.3kg (~5lbs.) lower in adults consuming whey protein in comparison to consuming carbohydrate. Body fat mass of the whey protein group was 1.1kg (~2.4lbs.) lower than the soy protein group, but was not significantly different.

The finding of a reduced waist circumference with whey protein consumption is important as previous research has identified abdominal fat tissue to be associated with metabolic complications in obese individuals, including metabolic syndrome, type 2 diabetes mellitus and cardiovascular disease.[38,39]

For body weight and fat mass, there were no differences observed between soy protein and carbohydrate consumption. Thus, only whey protein intake led to lower body weight and fat mass in comparison to carbohydrate feeding. Waist circumference was 2.4cm lower in overweight and obese adults supplemented with whey protein than in the both the soy protein and carbohydrate feeding groups. The finding of a reduced waist circumference with whey protein consumption is important as previous research has identified abdominal fat tissue to be associated with metabolic complications in obese individuals, including metabolic syndrome, type 2 diabetes mellitus and cardiovascular disease.[38,39] A large study involving 29 countries and nearly 4200 study participants revealed that insulin resistance, inflammatory markers and liver fat were all elevated with abdominal fat in both men and women.[40] Excess abdominal fat was independently associated with the development of prediabetes and diabetes in obese adults in the Dallas Heart Study.[41] Results from postmenopausal women in the Iowa Women's Health study indicated a strong interaction between diabetes and an elevated waist-to-hip ratio in the development of bladder cancer that led researchers to believe was an outcome of greater insulin resistance and inflammation from abdominal obesity.[42]

Increased abdominal fat has also been identified as a strong predictor of all-cause mortality.[43-45] In other words, greater abdominal fat is linked with the number of deaths from all causes, including heart disease, cancer and other diseases.

Clinical studies have examined the consumption of whey protein alone, in comparison to carbohydrates or other proteins, supplementation in relation to the timing of an exercise routine and over several weeks of an exercise program. In general, studies support higher protein intake and a beneficial effect in the preservation of lean mass.[46] Indeed, research suggests that whey protein consumption, when part of a resistance exercise program, promotes the maintenance and/or increase of lean mass and may help reduce body fat.[47] Moreover the consumption of whey and higher protein diets may be beneficial when dieting. A recent review of the literature indicates that the consumption of higher protein diets compared to standard-protein, low fat diets can help produce more favorable changes in body weight/fat and help limit muscle loss when consuming energy restricted diets.[48] In addition, use of low-fat higher protein diets containing whey or casein may be more effective for weight maintenance following weight loss without adversely effecting metabolic and cardiovascular risk factors than low-fat high carbohydrate diets.[49]

The beneficial body composition outcomes linked to whey protein consumption is further illustrated in studies that looked at effects on blood lipids. For example, researchers examined the effects of whey protein on lipemia (the presence of an excess of lipids in the blood) in obese middle-aged and older adults.[50] Supplementation of a fat rich mixed meal with whey protein reduced postprandial lipemia when compared to supplementation with cod protein and gluten. This is relevant since lipemia following food consumption is associated with cardiovascular disease. The researchers concluded that long-term dietary supplementation with whey protein may prove beneficial in preventing cardiovascular disease in obese adults. Similarly, researchers investigating the postprandial effects of different protein types (45g whey, casein, gluten or cod protein) on postprandial lipemia after a fat-rich test meal in adults with type 2 diabetes found that whey protein added to a fat-rich meal significantly reduced the postprandial triglyceride response and suppressed the free fatty acid response when compared with casein, cod, and gluten.[51] Since it is established that elevated and prolonged triglyceride responses following food consumption increases cardiovascular disease risk in adults with type 2 diabetes, whey proteins may outperform other proteins in post-prandial lipemia improvement, which may ultimately lead to cardiovascular benefits.

Whey Protein Consumption Is Linked To Favorable Cardiometabolic Outcomes

Metabolic syndrome is clinically identified by a blend of various metabolic risk factors including abdominal obesity, elevated triglycerides, blood pressure, and fasting glucose levels, and lowered HDL-cholesterol.[52] The presence of metabolic syndrome increases the risk of developing heart disease and other health problems including type 2 diabetes mellitus and stroke.[53] The prevalence of metabolic syndrome in the U.S. remains high, impacting approximately 34% of the population ≥20 years of age, with increasing prevalence as the population ages. Males ≥ 60 years of age are more than four times as likely compared to younger men to meet metabolic syndrome criteria, and females ≥ 60 years of age are more than six times as likely compared to younger women to present metabolic syndrome.[54]

Effects on Cholesterol

Diet remains an important determinant in controlling risk factors of metabolic syndrome. Several recent studies have shown that whey proteins may play a beneficial

role in metabolic syndrome. A study in overweight and obese adults revealed cholesterol lowering benefits following a daily 60g whey protein supplement. Twelve weeks of whey protein intake reduced total cholesterol, LDL cholesterol and triglyceride levels by 11%, 9.6% and 22%, respectively, in comparison to a control treatment.[55] Previous reports have suggested that decreases in LDL-cholesterol from five to 55% translate to a 25-45% reduction in risk of coronary heart disease.[56] Another study in healthy adults consuming fermented milk supplemented with whey protein concentrate found that HDL-cholesterol was significantly elevated at four weeks in comparison to a control treatment that showed no change. Triglyceride levels in the whey protein group were also significantly decreased in comparison to the control group.

Blood Pressure and Arterial Stiffness

Systolic blood pressure was decreased following consumption of fermented milk with whey protein concentrate for eight weeks, while no effects were observed with consumption of the control treatment.[57] Declines in systolic blood pressure, as small as 3mm, could lead to an 8% reduction in stroke mortality and a 5% reduction in mortality from coronary heart disease.[58] Similarly, another trial in young and older overweight adults found that systolic and diastolic blood pressure were significantly reduced after 12 weeks compared to baseline blood pressure in both the casein and whey protein treatment, but not in the control.[59] Of interest, this study was the first to examine the effect of whey proteins on arterial stiffness (i.e. hardening and loss of elasticity of the arteries), a measure of cardiovascular health. At six weeks, there was a significant reduction (7.3%) in arterial stiffness in adults consuming whey protein compared to the control, while at 12 weeks, an additional reduction (14%) was seen in the whey protein group. Arterial stiffness remained unchanged in the casein-supplemented group at both six and 12

Applications: Guidelines To Improve Body Composition

Using whey protein to build muscle mass

An abundant supply of the essential amino acids to muscle during resistance training is shown to enhance the anabolic stimulus by up to 400%.[56] To achieve this effect:

- Take a serving of whey protein (20-40g) with a dose of carbohydrates (glucose) (20-40g) mixed in water within the hour before resistance training exercise.
- Additionally, take the same mix immediately after resistance training.
- A single bout of resistance training exercise can stimulate muscle protein metabolism for up to 36 hours.[37] To minimize the muscle breakdown response and maximize the anabolic stimulus that resistance training provides,
- Consume a serving of whey (20-40g) with a source of carbohydrates and some fat several times throughout the day. Mix or blend a serving of whey (concentrate of isolate) in 6-10 ounces of skim milk with some fruit and a table spoon of canola or flaxseed oil.

Research shows that when whey is consumed as part of a mixed macronutrient meal (with carbohydrate and fat), a strong and persistent inhibition of muscle breakdown is observed along with stimulation of protein synthesis.[51]

Using Whey Proteins To Enhance Fat Loss

- As a natural appetite suppressant, take a small serving (20-30g) of whey protein (isolate or concentrate) mixed in seven or eight ounces of water, 30min. before a meal.

Research suggests that consuming a whey protein shake 30min. before a meal ensures greater satiety from consuming fewer calories.

- To enhance fat utilization and muscle preservation during exercise, consume a small serving of whey (isolate or concentrate) mixed in water, 30min. before exercise.

Research suggests that whey supplementation before exercise enables more effective fat utilization (oxidation) and preservation of muscle.

weeks from baseline.[59] Arterial stiffness has been identified as an independent risk factor for cardiovascular disease.[60]

Glucose Response

Whey protein intake has also been shown to reduce postprandial glucose response due to the insulinotropic effects of whey's amino acids.[61] A recent clinical study in healthy lean men involving the comparison of whey protein intake relative to three other protein sources (egg white, turkey, and tuna) demonstrated that the whey protein caused a significant reduction in glucose response at 30min. following the meal, compared to the tuna, turkey and egg meals. At 60min. post meal consumption, the glucose response remained significantly lower with whey protein in comparison to the turkey and egg meals, but not with the tuna meal. Similarly, when considering insulin responses following the protein meals, insulin levels at 30 and 60min. with whey protein were significantly higher than those with the tuna, turkey and egg meals. At 90min. postprandially, only the whey protein meal showed significantly greater values than the turkey and egg meals, suggesting whey to have strong insulinotrophic properties.[62] This is consistent with another study in healthy lean men where whey protein consumption led to significantly greater insulin levels compared with soy and casein protein or a glucose control.[63] In another diet-controlled investigation in adults diagnosed with type 2 diabetes mellitus, whey protein, when given before or with a high-carbohydrate meal, resulted in a substantial reduction in postprandial glycemia.[64] The magnitude of the reduction was comparable to pharmacological therapy, such as sulfonylureas—a type of drug used to treat type 2 diabetes, which acts by increasing the release of insulin from the pancreas. Earlier research in adults with type 2 diabetes has showed comparable results, such that insulin responses were elevated following a high-glycemic index breakfast and lunch meal when whey protein was added to the meal compared to when whey was not included. Following lunch, blood glucose response was lowered by 21% with whey protein consumption compared to the control.[65]

Evidence is emerging to show cardiometabolic benefits linked with whey protein consumption, focusing on blood pressure, vascular function, glucose/insulin responses and triglycerides, which ultimately may be translated into reducing the risk of chronic diseases, such as cardiovascular disease and type 2 diabetes mellitus, and the development of metabolic syndrome.[61]

Whey And Satiety

Of all the macronutrients, protein has the most exceptional appetite-suppressing effects. However, a recent study suggests that whey may be the most effective protein at suppressing hunger and make dieting for fat loss easier. In a series of trials, consumption of whey protein before a meal significantly reduced hunger and increased the feeling of satiety from eating less food. When the participants drank a whey shake 30min. before a meal they felt more satisfied when consuming fewer

calories.[66] The researchers discovered that whey stimulates much higher levels of two gastrointestinal hormones that control appetite; cholecystokinin and glucagon-like peptide-1. Consuming whey increased the levels of these hormones by 60% compared with drinking a regular protein (casein) supplement. Therefore, consuming a small serving of whey (30-40g) before a meal may reduce hunger and take the difficulty out of following a calorie-restricted diet to make weight loss much easier.

Dietary proteins are not all equal when considering their influence on satiety and food intake. A study involving healthy young adults consuming approximately 50g of various dietary proteins (egg, turkey, tuna and whey) at breakfast highlighted whey as the superior protein in reducing appetite and food intake at a lunch buffet-style meal four hours later. Calorie intake at the buffet meal was significantly lowered when adults consumed whey protein in comparison to egg, turkey and tuna protein meals.[62] Similarly, earlier research demonstrated that whey protein intake consistently suppressed food intake relative to a control, a carbohydrate, soy or egg protein treatment. Specifically, young adult males were fed a beverage containing either isolates of whey, soy, or egg albumen and then offered a pizza meal one to two hours later. Whey protein intake resulted in decreased food intake at both one and two hours, relative to the control and the other treatments.[67] Other clinical work has suggested that timing of whey protein intake may be an influential factor in the regulation of food intake and satiety. Whey protein in the range of 20-40g significantly reduced food consumed when provided to young adults 30min. prior to an "all you can eat" pizza meal.[68] These clinical studies supports a role for whey in appetite suppression and food intake regulation, making whey protein a strong candidate in food applications targeting appetite control and satiety.

Increasing the ratio of protein in the diet is now considered a safe, effective strategy that lowers blood lipid concentrations, improves insulin/glucose metabolism and enhances fat loss.[55] Due to the multitude of benefits it provides, whey should be the first protein source considered when health-conscious people choose to increase their protein intake.

Scientifically Supported Claims Involving Whey Protein And Muscle Benefits

The Dietary Reference Intakes for Macronutrients report (2005) highlighted the role of dietary protein in the synthesis of muscle tissue: "dietary protein is not only needed for maintaining protein turnover and the synthesis of physiologically important products of amino acid metabolism but is, of course, laid down as new tissue."[69] The Joint Position Statement by the Academy of Nutrition and Dietetics (formerly American Dietetic Association), Dietitians of Canada and the American College of Sports Medicine have stated, 1) "protein consumed after exercise will provide amino acids for building and repair of muscle tissue"; and 2) "… high-quality proteins such as whey, casein, or soy are effectively used for the maintenance, repair, and synthesis of skeletal muscle proteins in response to training."[17] The International Society of Sports Nutrition position statement on Protein and Exercise stated the following:

> "Timing of protein intake in the time period encompassing the exercise session has several benefits including improved recovery and greater gains in fat free mass. Protein residues such as branched chain amino acids have been shown to be beneficial for the exercising individual, including increasing the rates of protein synthesis, decreasing the rate of protein degradation, and possibly aiding in recovery from exercise. In summary, exercising individuals need more dietary protein than their sedentary counterparts, which can be obtained from whole foods as well as from high quality supplemental protein sources such as whey and casein protein."[70]

Increasing the ratio of protein in the diet is now considered a safe, effective strategy that lowers blood lipid concentrations, improves insulin/glucose metabolism and enhances fat loss.[55]

In addition to authoritative recommendations and position statements involving protein and muscle health, there are a growing number of studies supporting functional benefits following consumption of whey protein in combination with resistance exercise. Thus, developing evidence-based communications to consumers becomes an exciting opportunity for the whey industry. A substantial level of scientific substantiation may support several claims outlined in Table B.

Table B: Scientifically Supported Potential Claims for Consumer Communications*

Potential Structure/Function Claims for Whey

Whey protein can help build and maintain muscle

Whey protein intake promotes muscle health

Whey protein intake promotes healthy muscle

Potential Claims for Whey and Exercise Combined

Whey protein, a high quality protein, in combination with resistance exercise helps:

- Promote muscle protein synthesis.
- Build new muscle and reduce muscle breakdown.
- Build lean muscle mass.
- Nourish your muscles after a workout.
- Increase muscle mass.

Whey protein, a high quality protein, may help promote muscle repair and recovery following exercise.

*Sources: Rodriguez, Di Marco, Langley 2009.[17] IOM, Food and Nutrition Board 2005.[69] Campbell, Kreider et al 2007.[70]

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