Nutritional Benefits *of* Dairy Proteins

IN THE MANAGEMENT OF MALNUTRITION AND STUNTING PREVENTION

Dairy proteins are a safe, high-quality protein source for therapeutic and supplemental nutrition worldwide, as well as versatile ingredients in common foods.

With nearly a quarter of the children under age 5 around the world stunted, and nearly 52 million wasted (UNICEF et al., 2017), dairy and whey proteins can be used in supplementary and therapeutic foods to help improve malnutrition recovery rates, promote linear growth and, most importantly deliver lean body mass accretion benefits.

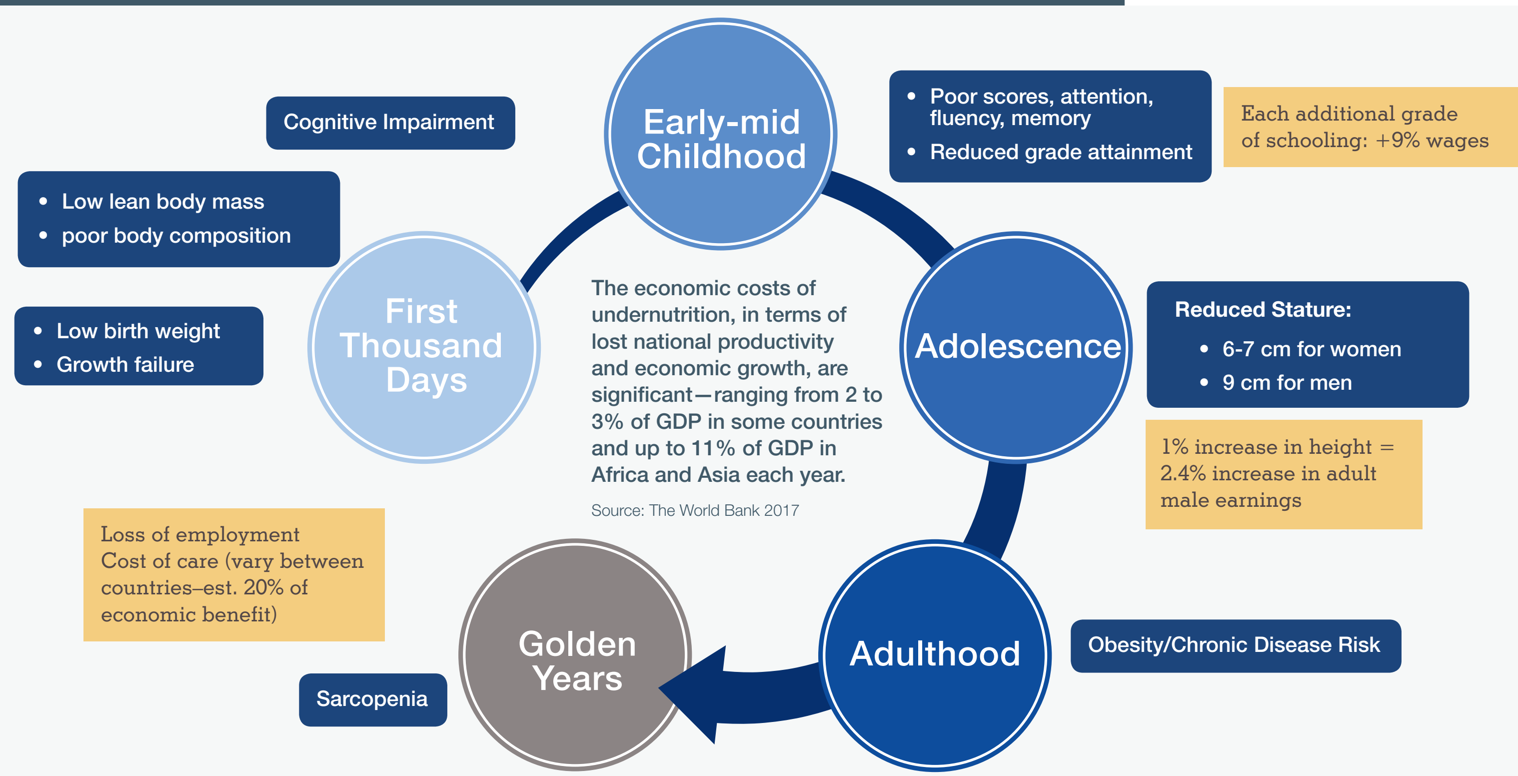
In fact, new evidence indicates that the provision of high quality dairy proteins, including whey proteins and milk powders, to pregnant mothers, does have an impact not only on birth weight, but perhaps most importantly, on the lean body mass of their baby. This, in turn, along with the provision of high quality proteins during the first two years, is likely to have a lasting impact, protecting from central fat obesity, diabetes and other chronic diseases later in life.

Dairy protein supplementation can be part of the "health and nutrition arsenal" available to meet the United Nation's Sustainable Development Goals.

Milk and whey protein are widely available as an ingredient and traded worldwide. Advances in processing have resulted in great improvements in their functionality and organoleptic properties.

A wide range of products are available at various price points, allowing their use in cost-effective, therapeutic and supplementary products in a wide variety of contexts, cultures and settings.

Stunting Leads to Reduced Productivity and Impacts Economic Growth



Dairy for Global Nutrition and USDEC fully support the International Code of Marketing of Breastmilk Substitutes and other global nutritional policies set forth by the World Health Organization, UNICEF, World Food Programme, the Codex Alimentarius, etc.

Reducing low birth weight, a risk factor for childhood stunting.

Studies show an association between birth weight and moderate milk consumption by the pregnant mother, and demonstrate links between the consumption of dairy and reduced risk of intrauterine growth retardation, and increased birthweight.

Inadequate nutrition of women during pregnancy can result in intrauterine growth retardation (IUGR) of the fetus and delivery of an infant with low birth weight (<2500g). Numerous dietary pattern studies have been conducted within the last decade and these have been reviewed recently (Grieger & Clifton, 2015; Clark, 2016). Although the studies were conducted on mainly healthy and well-nourished Western female populations, they did reveal links between consumption of dairy products and lower risk of IUGR and increased birthweight. In contrast, subjects consuming diets with a high content of processed foods, confectionery and soft drinks showed an increased occurrence of low birth weight deliveries. Low birth weight is a risk factor for childhood stunting (Aryastami et al., 2017). Out of six dietary pattern studies reviewed by Brantsaeter et al. (2012), four showed a positive association between birth weight and moderate milk consumption by the pregnant mother.

Two of the studies reviewed by Brantsaeter et al. (2012) indirectly identified a possible role of whey protein in fetal growth in utero. Heppe et al. (2011) analyzed data collected in the Dutch Generation R Study that addressed fetal life until young adulthood in Rotterdam. They found that maternal milk consumption of greater than three glasses per day was associated with fetal weight gain in the third trimester of pregnancy, resulting in an 88 g (95% CI: 39, 135 g) higher birth weight compared to consumption of 0-1 glasses per day. This association appeared to be limited to whey protein as intake of protein from non-dairy sources or from cheese was not associated with birth weight increase. Similarly, Olsen et al. (2007) using data from the Danish National Birth Cohort, found that milk consumption was positively associated with higher birth weight for gestational age, lower risk of small for gestational age (SGA) births, and higher risk of large for gestational age births.

Interestingly, Olsen et al (2007) compared associations relating to non-dairy proteins, milk products excluding cheese and ice cream and cheese protein. Their findings revealed that birth weight was constant across quintiles of non-dairy protein intake, suggesting that the associations found with dairy protein were not a general protein attribute.

Currently, the available evidence is insufficient to come to an informed conclusion about the possible association of maternal whey or milk protein intake with birth weight, in particular in emerging economies, but the findings described above are intriguing and merit more focused investigation.

Managing malnutrition during infancy: Milk, dairy proteins demonstrated to be an effective and affordable supplement for malnutrition in young children.

Higher recovery rates are observed for less than 1 cent per daily ration. The additional cost of dairy is quite minimal for the significantly higher recovery rate achieved.

Inclusion of dairy leads to improved outcomes in children with moderate malnutrition with only a marginal increase in cost of approximately $1 per child who recovers.

Severe Acute Malnutrition (SAM) and Moderate Acute Malnutrition (MAM) are conditions that afflict those within the first 1,000 days of life, conception to 24 months, as well as other children living in vulnerable countries (WHO, WFP, UN & UNCF, 2007). The impact of SAM and MAM is most devastating in early life, associate with increased stunting, morbidity and mortality (WHO et al., 2007). These conditions are managed with ready-to-use therapeutic foods (RUTF), the established standard of care for the community-based management of SAM (WHO, 2007).

Whey proteins were recently demonstrated to be an effective and affordable recovery agent for malnutrition in young children (Bahwere et al., 2014; Stobaugh et al., 2016). In a randomized clinical effectiveness trial among rural Malawian and Mozambican children, significantly more children recovered from MAM when fed a whey-based supplement compared to a soy-based supplement (Stobaugh et al., 2016). In addition, children fed the whey-based supplement demonstrated better markers of growth during treatment (Stobaugh et al., 2016). Of importance is that when tested against a standard milk-based recovery supplement, a whey protein-based supplement was equally effective at treating SAM, and was a cheaper alternative to standard milk-based supplements (Bahwere et al., 2014).

A requirement for the inclusion of dairy protein in RUTF and fortified blended foods (FBF) was established by the US Department of Agriculture in 2015 (USDA, 2015). The regulation requires 50% of protein to be from dairy in RUTF, and 33% in RUSF. Whey proteins and other milk proteins can be used to meet these requirements. Earlier in 2008, the USAID food aid quality review project recommended whey proteins be included in FBF. UNICEF introduced a standard in Codex in 2016, which features a minimum content of dairy proteins, along with a substantial body of evidence that demonstrates higher and faster recovery rates from SAM when dairy ingredients are included (Stobaugh et al., 2016).

The effectiveness of whey protein concentrate as an economical alternative to skim milk powder/nonfat dried milk has been proposed (Hoppe et al., 2008) and is the subject of several promising studies. Stobaugh et al. (2016) compared the effectiveness of a peanut-based RUSF containing whey protein and whey permeate with soy protein-containing control in a trial conducted in rural Malawi and Mozambique. They found that a significantly higher number of children recovered from MAM in the whey protein-containing RUSF group (83.9%) compared to the group receiving the soy protein-containing RUSF (80.5%), which had a higher protein and calorie content. In addition, those consuming the whey protein RUSF demonstrated better growth markers. The researchers concluded that the whey protein RUSF resulted in higher recovery rates and improved growth than did the soy protein even though the whey protein RUSF provided less protein and energy than the soy protein control. Hoppe et al. (2008) studied the effectiveness of FBF containing whey protein or skimmed milk powder, and determined that whereas protein quality was improved, cost was increased. Thus, randomized intervention trials testing the effectiveness of milk-protein-based FBF in vulnerable populations is warranted (Hoppe et al., 2008).

In the context of MAM, Bahwere et al. (2014) reported that milk powder comprised about 30% of the ingredient content of RUTF and contributed to approximately 50% of the cost. The researchers explored the economics and effectiveness of substitution of the skimmed milk powder component with WPC35 and reported that the effectiveness of the WPC-based RUTF was comparable to the SMP control with respect to recovery rate from SAM, average weight gain and length of stay. Weber & Callaghan (2016) described a free access, linear programming tool that alongside other capabilities, supports the calculation of lowest cost formulations for supplementary foods products that to date has been used successfully in the design of over 20 products.

While the dairy component of RUFs is indeed more expensive than alternative proteins, some authors have suggested that the actual difference of cost in a daily ration is minimal. Batra et al. (2014) stated that "although milk protein is more expensive than ingredients such as soy isolate, the difference is currently not large…it was only $0.0017 per 92 g daily ration (2015 cost)." The study demonstrated that only products containing 33% dairy resulted in increases in MUAC (Batra et al., 2014).

Stobaugh et al. (2016) conducted a study where the production cost of the soy supplement was $2.78/kg, and that of the whey protein supplement was $3.13/kg. Researchers calculated that the total amount of RUSF provided until recovery for a 7 kg child was just over 3 kg, resulting in a very small difference per child who recovers. The authors further stated that, "in the larger context of the operational costs of a supplementary feeding program that includes staff, logistical support and facilities, this additional cost is quite minimal for the significantly higher recovery rate achieved," and that "…inclusion of dairy leads to improved outcomes in children with MAM with only a marginal increase in cost."

Linear growth is important, and dairy, whey proteins contribute to this effect.

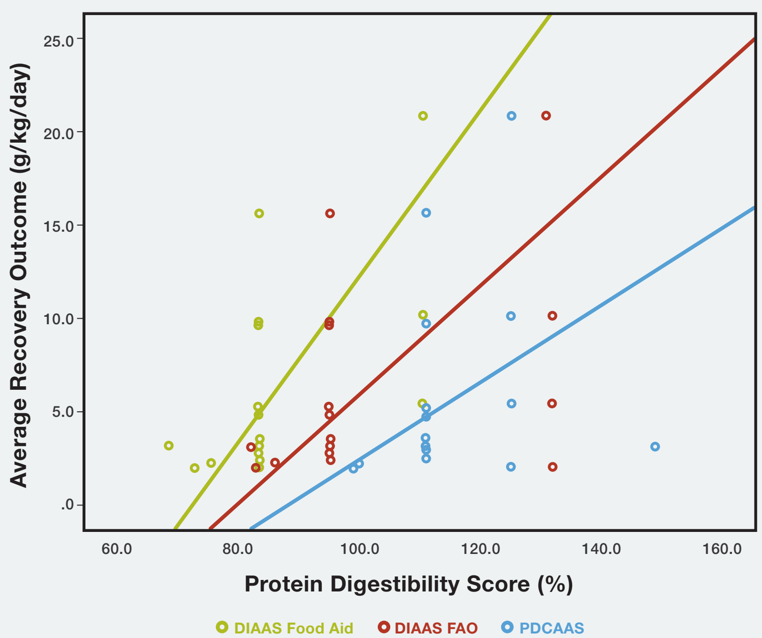
Recovery from stunted to non-stunted height for age score has been associated with improved cognition. Dietary patterns specific to dairy intake have been positively associated with changes in length for age score.

Researchers have found that the introduction of animal sourced foods such as dairy products, to children's diets is important, given their nutrient profile that include high quality protein, bioavailable nutrients and possibly other bioactive components that are essential for growth. While breastfeeding throughout the first year is recommended, it is important to introduce dairy products as part of complementary foods to optimize linear growth.

A recent meta-analysis examined the relationship between linear growth and child development in low- and middle-income countries (Sudfeld et al., 2015). Researchers reviewed 68 published studies from 29 different countries, and found the data indicated that improvement in height-for-age over time or recovery from a stunted to a non-stunted height-for-age score was associated with improved cognition. They concluded that in low- and middle-income countries, linear growth was positively associated with cognitive and motor development, and that "without intervention, early cognitive deficits may persist throughout childhood for children experiencing restricted linear growth during the first 2 years of life." One of the plausible mechanisms explaining the relationship is that chronic infection and protein malnutrition may delay the development of early motor skills (Sudfeld et al., 2015).

There is little research available on how children's dietary patterns are related to growth. A recent study conducted in Peru examined the dietary intakes of children 6-8 months and found that their dietary pattern score specific to dairy intake was positively associated with changes in length of age scores (Arsenault et al., 2016). The authors stated that "the introduction of animal source foods, such as dairy products, to children's diets is important given their nutrient profile that includes high quality protein, bioavailable nutrients and possibly other bioactive components that are essential for growth." Whereas breastfeeding throughout the first year is recommended, the study suggests it is important to introduce dairy products as part of complementary foods to optimize linear growth (Arsenault et al., 2016).

Relationship Between Protein Score and Average Recovery Outcome in Children Treated for SAM with RUTF/F100



Manary M. Protein Quality and Growth. Adapted from presentation given at: EB 2015. Protein Quality, Growth and Malnutrition: Latest Scientific Findings and the Role of Dairy in Food Aid, Dairy for Global Nutrition Symposium; 2015 March 30; Boston, MA.

The quality of protein does matter. Dairy scores above all.

When looking at all the protein quality scores, dairy protein is likely to be higher, and particularly for malnourished children, dairy proteins are associated with higher growth.

Milk and whey protein is considered a high-quality protein. According to the Digestible Indispensable Amino Acid Score (DIAAS) method developed by The Food and Agricultural Organization of the United Nations (FAO) (FAO, 2013), which measures the digestion of specific amino acids rather than crude protein levels, milk and whey proteins are a higher quality protein than soy protein. Overall, researchers agree that there is a clear association between the quality of protein available at national level and the prevalence of stunting, and that more research is needed in infants 6 months and older to examine the relationship between protein quality, linear growth, and the prevention of stunting (Ghosh, al., 2012). Researchers examined the results of six clinical trials and established correlations between rates of weight gain and protein quality. Using the DIAAS Food Aid Score, the findings indicated the greatest recovery outcome per unit protein digestibility score (Manary et al., 2016). The researchers concluded, "when looking at all the protein quality scores, dairy protein is likely to be higher, and particularly for malnourished children, dairy proteins are associated with higher growth" (Manary et al., 2016).

Furthermore, considering the specific pattern of whey proteins, it is clear they can be used to improve the pattern of complementary foods based on local ingredients and boost the overall DIASS score. Additional research is underway to document the specific benefits of dairy proteins with regards to linear growth, in particular the exact amount that will prove to be most cost effective.

A study of weight gain and recovery rates amongst Malawian children (Ackatia-Armah et al., 2015) found that weight gain from baseline was greater with RUSF containing a whey/soy isolate blend than with the locally processed vegetable protein-containing blends, and was intermediate with CSB++, also known as Super Cereal Plus, which is an FBF containing some skimmed milk powder. Sustained recovery rates were higher with the RUSF compared to any of the other treatments. It is important to note that the protein content of the RUSF at 12.5 g was significantly lower than any of the other treatments (15.5-18.5 g). These findings indicate that quality of protein, rather than quantity of protein, is critical. Further, Manary et al. (2016) provided evidence that the current method for assessment of protein quality, the DIAAS (FAO, 2013), significantly underestimates the demand for indispensable or essential amino acids by malnourished individuals as the calculation of protein quality is based on a reference pattern from healthy children. While DIAAS is currently considered superior to the measurement standard known as PDCAAS (Protein Digestibility — Corrected Amino Acid Score). This claim may be supported by the results of a recent study by Batra et al., (2014) which examined two levels of dairy proteins, 15 and 33% of total protein, in RUSF fed under supervision to school children (3-5 yr) in Guinea-Bissau. Researchers found that RUSF-33%, but not RUSF-15%, eliminated a decrease in mid-upper arm circumference (MUAC), a measure of wasting, that was observed in controls (20.01 cm in RUSF-33% compared with 20.34 cm in controls, $P < 0.05$).

The Double Burden of Malnutrition: a growing concern in emerging countries.

Overweight and obesity, a global epidemic of overnutrition, are now linked to more deaths worldwide than underweight. Dairy, whey proteins play a potential role in helping to reduce overnutrition and optimize body composition.

Current evidence from a large body of research indicates that consuming whey protein, with or without resistance exercise, helps to optimize body composition in both young and older adults. Whey protein in particular, can help improve body composition, with specific impact on reduction of abdominal fat.

According to a systematic review and meta-analysis of 16 randomized controlled studies and 20 prospective cohort studies, current evidence shows no adverse effects of higher protein diets on bone health in adults. Consumption of dairy proteins as a supplement, even at high daily doses is safe and effective.

Whereas recovery from MAM as a simple outcome is important, what is really critical is not only linear growth but also lean body mass accretion. In South Asia, and part of south-east Asia, it has been documented that low birth weight is linked to low lean body mass, which results in a higher fat mass versus lean body mass ratio later in life.

Fetal undernutrition, and lack of lean body mass accretion early in life predisposes one to hyperlipidemia, insulin resistance, and central obesity (Kulkarni et al., 2014). Researchers now advocate for the provision of supplementary foods fortified not only in micronutrients but also in quality proteins. Ideally, mothers' milk does provide large quantities of whey proteins, but in developing countries, where the mother is herself malnourished, or may not be able to lactate beyond a few months, the reality is that high quality complementary foods, providing whey proteins, need to be provided (Kulkarni et al., 2014).

In conclusion, there is significant evidence from numerous studies showing an association between inclusion of dairy proteins, including whey proteins, and reduction in the incidence of wasting and stunting in the prenatal diet and from 6 months and up. To a limited extent this is supported by data from randomized, controlled trials but more data are needed to define the most efficient and economical treatment. Such trials must not only establish the minimum effective level of dairy or whey protein as a function of recovery rate, such that the cost effectiveness of inclusion of dairy/whey protein can be accurately assessed.

A key strategy is to provide enrichment of complementary foods with high quality proteins such as whey proteins. In the past, availability of these proteins was limited, but they are now widely available in international trade, and can be used for therapeutic purposes for the management of malnutrition, the cost-effective prevention of stunting, and optimization of lean body mass.

Overweight and obesity, a global epidemic of overnutrition, are now linked to more deaths worldwide than underweight (WHO, 2016a). As of 2014, 41 million children under the age of 5 were overweight or obese, 1.9 billion adults were overweight, and over 600 million adults were obese (about 13% of adults, worldwide) (WHO, 2016a). Once considered conditions of the developed world, overweight and obesity are now affecting low- and middle-income countries (WHO, 2016a). For example, overweight or obesity nearly doubled in Africa from 5.4 million to 10.6 million between 1990 and 2014 and nearly half of the world's children under the age of 5 who were overweight or obese in 2014 lived in Asia (WHO, 2016a). Overweight and obesity are primary risk factors for non-communicable diseases such as cardiovascular diseases, diabetes, musculoskeletal disorders and some cancers (WHO, 2016a).

Higher protein diets may be effective for weight loss because of changes in energy metabolism and appetite signaling that promote decreased energy intake (Leidy et al., 2015). Furthermore, during weight loss, high-protein diets can help maintain resting energy expenditure (Eisenstein et al., 2002; Halton & Hu, 2004; Leidy et al., 2015). Protein also has a greater effect on satiety than carbohydrate or fat, which may lead to reduced energy intake (Bosse & Dixon, 2012; Leidy et al., 2015).

A robust body of evidence indicates that the consumption of 1.2 – 1.6 g of protein/kg/d, with at least 25 – 30 g of protein per meal, will reduce body weight and fat mass while preserving lean mass and can be considered a successful strategy in the prevention or treatment of obesity (Clifton, 2012; Te Morenga & Mann, 2012; Westerterp-Plantenga et al., 2012; Dong et al., 2013; Leidy et al., 2015). In a randomized trial of 20 young men, higher protein diets of up to 2.4 g of protein/kg/d contributed to improved body composition by promoting lean body mass and loss of fat mass during energy deficiency combined with intense exercise for four weeks compared with higher protein diets of 1.2 g of protein/kg/d (Longland et al., 2016). These results indicate that dietary protein consumption higher than the Recommended Dietary Allowance during an energy deficit may help to further preserve lean body mass, particularly when combined with exercise (Longland et al., 2016).

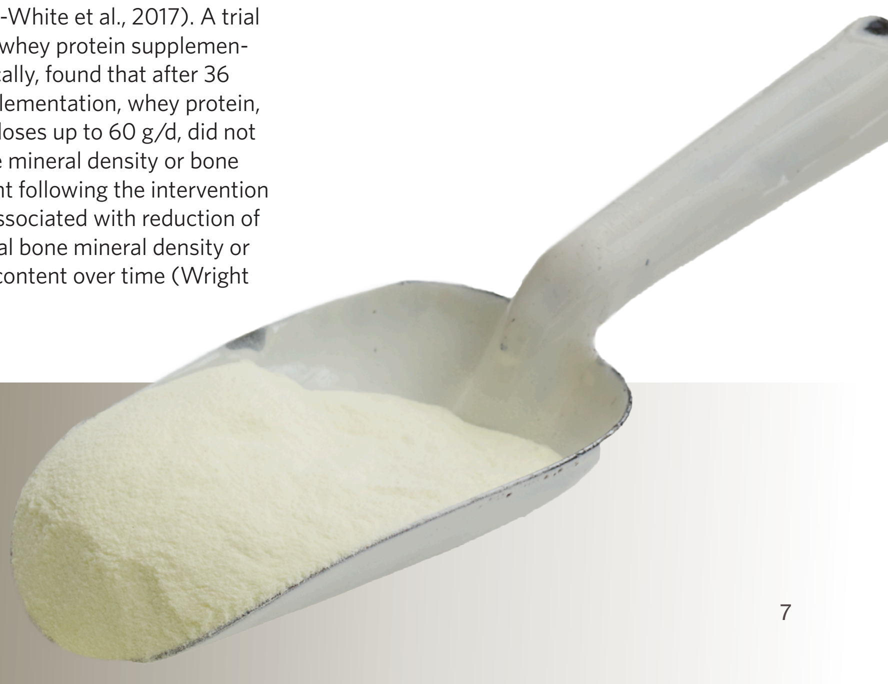
It is well accepted that resistance training in combination with adequate amounts of dietary protein can increase muscle protein synthesis in healthy adults, regardless of their age or gender (Hulmi et al., 2010). An emerging body of evidence, however, indicates that dairy protein, specifically whey proteins, may stimulate the greatest rise in muscle protein synthesis, thereby optimizing body composition compared with other non-meat protein sources (Hulmi et al., 2010). This is likely because whey proteins are considered a high quality protein (Loenneke et al., 2012). In a study that determined the relationship between the amount of quality protein, carbohydrate, and fat consumed and percent central abdominal fat, quality protein consumption was inversely associated with central abdominal fat (Loenneke et al., 2012). A randomized trial in non-resistance-trained men and women who consumed daily isocaloric supplements containing carbohydrate, whey protein, or soy protein showed that gains in lean body mass were greater in the group consuming whey protein than in the groups consuming carbohydrate and soy (Volek et al., 2013). The results indicate that protein quality may be an important determinant of lean body mass, particularly following resistance exercise (Volek et al., 2013).

High quality protein, such as whey protein, has also been demonstrated to be effective in improving body composition in untrained, free-living adults (Baer et al., 2011). In a randomized trial that was designed to test the effect of supplemental whey protein, soy protein and carbohydrate on body weight and composition in adults, body weight and fat mass were lower in the groups consuming whey protein and soy protein than the group consuming carbohydrate (Baer et al., 2011). Whereas lean body mass did not differ between groups, the group consuming whey protein had greater decrease in waist circumference than the groups consuming soy protein and carbohydrate (Baer et al., 2011).

A meta-analysis of 14 randomized controlled trials found that whey protein, with or without resistance exercise, improved body composition in adults (Miller et al., 2014). The effects of whey protein supplementation were beneficial whether the whey protein was added to the diet or used as a replacement for other proteins or carbohydrates in the diet, but were most pronounced when consumed as part of an overall healthy eating plan and combined with resistance exercise (Miller et al., 2014).

According to a systematic review and meta-analysis of 16 randomized controlled studies and 20 prospective cohort studies, current evidence shows no adverse effects of higher protein diets on bone health in adults (Shams-White et al., 2017). A trial that assessed whey protein supplementation, specifically, found that after 36 weeks of supplementation, whey protein, regardless of doses up to 60 g/d, did not influence bone mineral density or bone mineral content following the intervention and was not associated with reduction of total or regional bone mineral density or bone mineral content over time (Wright et al., 2017).

A robust body of evidence indicates that the consumption of 1.2 – 1.6 g of protein/kg/d, with at least 25 – 30 g of protein per meal, will reduce body weight and fat mass while preserving lean mass, and can be considered as a successful strategy in the prevention or treatment of obesity. Whey protein in particular can help decrease abdominal obesity.



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