Silver Fern Farms Nutrition Education:

Case Studies:

Family of Five:

The father is a teacher, the mother works for an accounting firm. They have three primary school aged children and live in Christchurch.

Key Theme/Nutrition Messages for the family case study: wholesome nutrition, balanced plate, family friendly meals that everyone will enjoy, showcasing quick and easy meals for a busy family.

Generation Jones / Older Couple with Grown Children:

The wife is a teacher, and the husband is a school principal. They have grown children and have several grandchildren. They live in Christchurch.

Key Theme/Nutrition Messages for an older couple are the importance of good quality lean red meat in support of the immune system (Zinc), iron, B12 status and protein for maintenance of lean muscle mass as we age.

Keto/Low Carb Millennial:

Female, 26 years old, flatting in Wellington. She works for the government and is following a Keto/ Low Carb style of eating.

Key Theme/Nutrition Messages for a young person following Keto/ Low Carb is around the good quality lean red meat and cholesterol profile- future proofing myself, being health conscious, protein and satiety, quality and source. Real food message rather than processed low carb/ keto foods- natural is best, bioavailability/ processing/ artificial ingredients.

Athlete: Gabby Sullivan

Gabby Sullivan is a University of Canterbury student and a top athlete. She is 23 years old, flatting and lives in Christchurch. Gabby captains the Canterbury Magicians and had her maiden call-up to the New Zealand women's cricket team in 2021.

Key Theme/Nutrition Messages are energy, muscle repair/ development, protein/ amino acids, iron, zinc. Achieving protein intake from real food (Silver Fern Farms red meat) rather than protein powders/ artificial sources. Real food for recovery rather than processed protein (eg protein powders, supplements, plant-based alternatives). Bioavailability of animal protein versus plant protein. Natural is best!

Additional information for Case studies:

- 12-week menu for each case study with recipes
- Measurements, blood test results
- Videos, photos from case study participants

Education pieces:

Education pieces highlighting the benefits of lead red meat- beyond the usual iron and protein messages (but these are still important messages!). Zinc, Vit B12, other B vitamins (niacin, riboflavin), omega 3 fatty acids etc

Education piece showcasing the scientific evidence supporting good quality lean red meat as part of a balanced diet. Discuss this in light of the Heart Foundation Statement.

Education pieces could be fact sheets, ‘bite-sized pieces of information’, short videos, photos, information pieces of website/ social media etc. Note a design agency will be engaged to clearly identify the content pillars under each audience and how this will look across social, web and other collateral.

Overall Recommendation: Eat lean red meat in moderation

A growing body of research suggests dietary advice to limit red meat is unnecessarily restrictive and not supported by current evidence. Studies that have explored the associations between red meat consumption and health outcomes have produced conflicting results (Micha 2010; Wyness 2011). Recently, research has begun to recognise that it is important to distinguish between unprocessed red meats such as beef, venison and lamb and processed meats such as bacon, ham, sausages, and salami.

Large cohort studies have recently reported no association between intakes of unprocessed red meat and any cause of death, including cardiovascular disease (CVD) or cancer (Kappeler 2013, Rohrmann 2013). This is consistent with the findings of the largest meta-analyses of the worldwide evidence showing no association between unprocessed red meat and coronary heart disease (CHD) (Micha 2010). Randomized controlled trials (RCT) have also demonstrated that, within the context of heart healthy diets, the effect of lean red meats on LDL-cholesterol is no different than white meats (Maki 2012, Roussell 2012). These findings are also in line with evidence that lean red meats have a relatively neutral fatty acid profile with respect to blood cholesterol levels (Wyness 2011).

Recent advances in our understanding of human requirements for key essential nutrients such as high-quality protein throughout the lifecycle also provide good reasons to emphasise the value of nutrient-rich foods such as lean red meat as part of a healthy diet. Red meats contain an array of important micronutrients such as iron, zinc, potassium and a range of B-vitamins including niacin, riboflavin, thiamine and vitamin B12 (Wyness 2011). These nutrients are all essential for optimal health throughout the lifecycle.

A decline in energy from nutrient-rich foods such as red meat, milk and eggs has been accompanied by an excessive increase in energy from fats (including trans fats) and refined carbohydrates found in many processed convenience foods (Slater 2009). These changes have likely contributed to obesity and chronic disease. In an era when people in developed nations are increasingly overfed, but undernourished, emphasising the value of eating a healthy balance of nutrient-rich minimally processed foods, including lean red meats, is likely to better serve public health.

How much lean red meat per week?

The scientific evidence shows that eating three servings of lean red meat a week is beneficial for your health. It is important to highlight to avoid and minimise processed red meat such as salami, bacon, ham, cured meats, fast food meats due in part to the high salt content and/or trans-fat content. Regularly eating foods high in salt and/ or trans-fat can increase your risk of developing cardiovascular disease.

The World Cancer Research Fund recommends keeping red meat intake to around three portions a week, equivalent to about 350-500grams cooked weight (World Cancer Research Fund).

The key is choosing the right cut and portions and balancing your intake of lean red meat with plenty of colourful vegetables, fruits, and other whole and unrefined foods such as fish, nuts, seeds, legumes, eggs, and wholegrains.

The World Health Organization (WHO) states that meat and meat-products "not only provide high-value protein but are also important sources of a wide range of essential micronutrients, in particular minerals such as iron and zinc, and vitamins such as vitamin A". It should be noted that meat and meat-products are the main source of vitamin B6 and the second source of niacin (Vitamin B3) (Celada 2016).

Lean red meat and cardiometabolic health: RCT's and Meta-analyses

Authors of a meta-analysis of 36 randomized controlled trials comparing red meat diets with diets that replaced red meat with a variety of other foods (i.e., plant protein, fish only, poultry only, mixed animal protein, carbohydrate, or usual diet) reported no significant differences in lipoprotein cholesterol, apolipoprotein (apo), or blood pressure responses between the red meat diets and all other diets (Guasch-Ferre 2019). Red meat diets in which only lean meat was consumed resulted in larger reductions in total cholesterol (TC) and LDL cholesterol compared with other diets (Guasch-Ferre 2019).

An intervention study has demonstrated that the consumption of a healthy Mediterranean-style dietary pattern with different amounts of lean beef (14, 71, or 156 g/d), improved lipids and lipoproteins when compared with a typical American dietary pattern containing 71 g/d of lean beef (Fleming 2021). Participants were in general healthy, with near optimal LDL cholesterol concentrations, more research should investigate the effects of a Mediterranean style diet with different amounts of lean red meat in a less healthy population. These findings are consistent with previous reported results from the Beef in Optimal Lean Diet (BOLD) study in which a Dietary Approaches to Stop Hypertension (DASH)-type diet, which traditionally limits beef to 28.3 g/d, was modified to include up to 141 g of lean beef per day (Roussell 2012). The increased beef diet was equally effective for reducing total-C, LDL-C, and non-high-density lipoprotein (non-HDL)-C, and was more effective for reducing apolipoprotein B, than the traditional red meat-limiting DASH diet. Similar findings also were observed with the inclusion of lean beef and pork (500 g/wk) as part of a Mediterranean-style diet compared with a Mediterranean diet containing 200 g/wk of beef or pork (O'Connor 2018). A dose–response analysis revealed no attenuation of the LDL-lowering response with increasing quantities of lean beef when incorporated into a MED diet.

Regarding beef specifically, a meta-analysis of eight randomized clinical trials comparing conventionally reared beef to lean white meat in a variety of diets found beef to be equally effective to white meat for reducing total-C, LDL-C, and triglycerides (Maki 2012).

A recent meta-analysis of randomized controlled trials reported that the effect of red meat on CVD risk factors is dependent on the comparison diet and the dietary substitutions made to incorporate red meat into the diet (Guasch-Ferré 2019). Current recommendations are focused on dietary patterns because nutrients, foods, and food components are not consumed in isolation, and the totality of the diet has a greater effect on health than the individual components.

A growing clinical evidence base suggests that lean, unprocessed red meat can be included as part of a heart-healthy eating pattern without adversely affecting CVD risk factors (Roussell 2012, Roussell 2014, Maki 2020).

In a randomized crossover study, consumption of a low saturated-fat (7%) Mediterranean diet with 500 g/wk (2.5 oz/d) lean unprocessed red meat reduced total cholesterol and LDL cholesterol after 5 wk of controlled feeding (O'Connor 2018). This study showed that adopting a Mediterranean style diet with or without reducing red meat intake improves CMD risk factors if the red meat is lean and unprocessed.

A meta-analysis of 24 RCTs assessing the effects of consuming ≥0.5 or <0.5 servings of total red meat per day on CVD risk factors showed that the consumption of ≥0.5 servings of total red meat per day did not influence blood lipids and lipoproteins or blood pressures in comparison with <0.5 servings per day (O'Connor 2017). These results align with a previous meta-analysis of 8 studies, which concluded that changes in blood lipids and lipoproteins did not differ when lean, unprocessed beef was consumed compared with poultry or fish (Maki 2012). O'Connor's meta-analysis of 24 studies is more generalisable as it was inclusive of a variety of red meat types and assessed blood pressure. It is important to emphasize that the conclusions of O'Connor's study do not support a cardioprotective effect of higher red meat consumption, such as is shown with fatty fish, but that the consumption of >0.5 servings of total red meat/d does not affect changes in blood lipids, lipoproteins, and blood pressures. In O'Connor's meta-analysis there was no visual threshold of total red meat consumption that indicates an apparent negative effect on blood lipids, lipoproteins, and blood pressures. They used the cut-off of 0.5 servings of total red meat/d, and they performed post hoc analyses to test if the studies with lower red meat consumption were washing out the effects of higher red meat consumption. The highest category of red meat consumption (>3 servings of red meat/d) showed no negative effects on blood lipid and lipoprotein concentrations and blood pressures and resulted in higher HDL concentrations.

With regard to other cardiovascular health effects, randomized clinical trial evidence supports the conclusion that neither red meat, nor beef specifically, adversely affects blood pressure and may even improve blood pressure and vascular reactivity when replaced with refined carbohydrate (Hodgson 2006). Randomised controlled trials also show that replacing some carbohydrates with protein may improve a number of cardiovascular risk factors, for example by lowering blood pressure (Hodgson 2006) and improving glycaemic control and blood triglyceride levels (Layman 2008, Nuttall 2008).

Dietary recommendations based on the 2010–2015 DGA (Dietary Guidelines Advisory Committee), with support from the 2015 Advisory Report, suggest that red meat consumption should be limited to approx. 0.5–0.7 servings/d or approx. 3.5–5 servings/wk (US Dept of Agriculture and Department of Health and Human Services 2015), this varies because the serving size range is 2–3 ounces. The Dietary Guidelines Advisory Committee search process has strict criteria that limit the inclusion of data from available RCTs, so this conclusion is based predominantly on epidemiologic associations. This restricts the conclusions to be mainly based on associative conclusions of morbidity and mortality rather than cause and effect of disease risk, both of which need to be considered in determining dietary guidance and public policy.

Red meat and cardiometabolic health: Epidemiological studies

Epidemiological studies suggest that higher red meat consumption is associated with increased risk of cardiovascular disease (CVD) (Zheng 2019, Bechthold 2019). Recent observational research which assesses unprocessed red meat independently of processed meat shows little or no association between unprocessed red meat consumption and CMD (Micha 2012). However, causation cannot be inferred from observational studies, and it remains unclear whether intake of red meat per se increases the risk of CVD or if these associations are because of other dietary and lifestyle behaviours that co-occur with red meat consumption. Importantly, in these epidemiological studies the isolated effect of red meat is difficult to disentangle from the rest of the diet. Furthermore, the definition of red meat is heterogeneous, and often unprocessed and processed red meat are examined as a single red meat exposure. Ultimately it is important to remember that regardless of contradicting evidence, an observational study design is unable to show causality such as with a randomized controlled trial (RCT).

Red meat, saturated fat, cardiovascular disease: Fatty acid profile of red meat

Restrictions proposed for red meat consumption stem from red meat as a source of saturated fat, which has historically been believed to increase the risk for heart disease. However, the relationship between saturated fat intake and risk for heart disease is complex, and recent evidence challenges earlier conclusions (Astrup 2011, Baum 2012).

The current scientific evidence reflects that dietary risk factors other than red meat may play an even larger role in diet-related disease risk. The relationship between SFA and heart disease depends to a large degree on the comparator. Replacing SFA with MUFA or PUFA may be beneficial, but replacing SFA with some other dietary components, such as refined carbohydrates, may increase the risk (Baum 2012). Research suggests that trans fatty acid intake, diets with a high glycemic index, and high dietary salt may be more significant risk factors for heart disease than dietary SFA. Furthermore, recent investigations suggest that increased consumption of refined carbohydrates is associated with increased cardiovascular risk.

A broader understanding of the fatty acid profile of lean red meat is important to understand its relationship with cardiovascular health. Fifty-four percent of the fatty acids in lean red meats such as beef and lamb are MUFA or PUFA. Of the SFA in beef, nearly one-third are stearic acid (18:0) which has a neutral effect on total cholesterol and low-density lipoprotein (Kris-Etherton 1997, Wyness 2011). Palmitic acid, another main saturated fatty acid in red meats, raises HDL as well as LDL cholesterol, therefore having little effect on the total to HDL cholesterol ratio (Mensink 2003). The 2010 DGAC report defined cholesterol-raising fatty acids as SFAs minus stearic acid. In several studies, when incorporated into low-fat, ""heart-healthy" diets, lean red meat has been shown to be equal to lean white meat for lowering total-C and LDL-C (Davidson 1999).

A systematic review by Li in 2005 concluded that, in diets with ≤10% SFA, fresh red meat consumed by healthy and mildly hypercholesterolemic persons was associated with reduced LDL-C (Li 2005).

A substantial amount of evidence supports the role of lean red meat as a positive moderator of lipid profiles with recent studies identifying it as a dietary source of the anti-inflammatory long chain

(LC) n-3 PUFAs and conjugated linoleic acid (CLA). Meat can make a useful contribution to intakes of long-chain omega-3 polyunsaturated fatty acids for those who consume little or no oily fish (Wyness 2011).

Recent evidence also challenges decades of advice to limit naturally nutrient-rich foods such as red meats in efforts to reduce saturated fat intake. According to a 2014 review and meta-analysis, current evidence does not support decades of dietary guidelines that encourage low consumption of saturated fat to promote heart health (Chowdhury 2014). This review takes into account evidence from 45 observational studies and 27 RCT on CHD risks based on dietary data from more than 600,000 people in Europe, North America and Asia. It appears that efforts to reduce saturated fat intakes may have resulted in increased intakes of refined carbohydrates. Furthermore, when compared with other modifiable dietary risk factors for cardiovascular disease, saturated fat intake has been deemed less of a risk than diets high in salt and industrially produced trans fats (Danaei 2009).

Lean meat is relatively higher in PUFA and lower in SFA compared with untrimmed meat. Trimming the fat off meat will affect the proportions of fatty acids, as visible fat is relatively higher in SFA, containing about 37 g SFA per 100 g meat.

Red meat also relatively low levels of PUFA; however, it can contribute substantially to intakes, providing 18 % of n-6 PUFA and 17 % of n-3 PUFA, while contributing to 23 % of overall fat intake. The main PUFA in red meat are the essential fatty acids, linoleic (n-6) and α-linoleic acid (n-3). When consumed, the body can convert α-linoleic acid into the long-chain beneficial n-3 fatty acids EPA and DHA. The rate of synthesis however is small, with studies generally suggesting conversion rates of α-linoleic acid to DHA of below 5%.

Red meat and type 2 diabetes:

Cohort studies (note, these types of studies cannot determine causation):

The authors of a review of 9 prospective cohort studies (450,000 total subjects) concluded that each 100-g serving of unprocessed red meat/d is associated with an increased risk of T2D (relative risk: 1.19; 95% CI: 1.04, 1.37) (Pan 2011). However, it is unclear whether the association of red meat consumption with increased T2D incidence is due to adverse physiologic effects of red meat consumption per se or confounding due to the correlation of red meat intake with other dietary and lifestyle factors that increase T2D risk (i.e., residual confounding).

Authors of a systematic review of prospective cohort studies with ≥1000 participants followed for 2–34 y concluded that dietary patterns lower in red and processed meat intake “may result in very small reductions in adverse cardiometabolic outcomes,” but acknowledged that observational studies are prone to residual confounding (Vernooij 2019).

Intervention studies:

Results from a limited number of intervention studies have shown that increasing unprocessed red meat intake does not adversely affect insulin sensitivity and other determinants of glucose tolerance, consistent with the possibility that the association in observational studies could be the result of confounding and not indicative of a causal relation. For example, a 4-wk diet containing ≥200 g/d red meat had no adverse effect on insulin sensitivity compared with a control diet that contained poultry and fish as the main protein sources (Turner 2015). These results are similar to those from the Beef in an Optimal Lean Diet (BOLD) controlled-feeding trial (all food provided), which showed no differences in fasting concentrations of insulin and glucose after 5 weeks of consuming a healthy American diet (20 g/d lean beef), a Dietary Approaches to Stop Hypertension

(DASH) diet (28 g/d lean beef), and 2 diets with higher intakes of lean beef: 113 g/d (BOLD) and 153 g/d (BOLD+) (Roussell 2012).

A study has shown that substituting lean, unprocessed beef (150g/day) as an isocaloric replacement for carbohydrate in a Healthy US-Style Eating Pattern resulted in no significant differences in effects on whole-body insulin sensitivity and other indicators of carbohydrate metabolism, lipoprotein lipids, apoA-I and apoB, hs-CRP, and blood pressures in men and women with prediabetes and/or metabolic syndrome (Maki 2020). These results are generally consistent with those from other studies showing that replacing dietary carbohydrate with protein has a neutral effect on insulin sensitivity.

Red meat and cancer:

The World Cancer Research Fund/American Institute for Cancer Research Project stated that there was convincing evidence of a causal relationship between red meat and processed meat consumption and colorectal cancer (World Cancer Research Fund & American Institute for Cancer Research, 2011, McNeill 2014). However, that conclusion has been controversial. The association is relatively modest and, in a range, where it is difficult to rule out bias and confounding as alternate explanations. These issues led to the decision by the 2010 DGAC to conduct another review that included only prospective cohort studies in humans published since 2000 (U.S. Department of Health and Human Services, 2010). The DGAC reported inconsistent positive associations between colorectal cancer and certain animal protein products, mainly red and processed meat, and concluded that, in general, studies showed no consistent findings with regard to the quantity and type of meat or meat product and colorectal cancer. Furthermore, the report stated that the studies examined often had little information on other factors, such as the way meat is cooked, which might be expected to affect the association. It is also important to consider that observational studies cannot reliably separate the relationships of the disease under study with individual components of a dietary pattern because of interrelationships among correlated dietary variables.

Why incorporate red meat in moderation into my dietary pattern?

Red meat is an excellent source of Protein:

Red meat is an excellent source of high quality bioavailable ‘complete’ protein (provides all 9 essential amino acids). Red meat contains on average 20–24 g protein per 100 g (when raw) and can therefore be considered a high source of protein. Your body cannot create essential amino acids, you must get them from your food. Amino acids are the building blocks of protein that your body needs to carry out basic bodily functions, including building and repairing muscles, production of structural tissues, hormones, transport molecules and antibodies. Researchers recommend that at least two meals (ideally three) a day should contain 25 to 30 g of high-quality protein from naturally nutrient-rich foods for optimal health.

While we can get protein from plant-based sources, the bioavailability is less than animal-based sources. On average the protein digestibility of plant-bases sources is reduced by about 10% in a vegetable-based diet due to the high fibre content of the diet. PDCAAS (protein digestibility-corrected amino acid score) overestimates the protein quality of plant proteins relative to animal proteins, with the result that it may appear that people consuming primarily plant proteins may be meeting their dietary requirement for protein and amino acids, when in fact they are not.

The current New Zealand RDI’s (Recommended Dietary Intakes) for protein intake are 0.75g/kg body weight/ day for women and 0.84g/kg body weight/ day for men. These values are estimates of the amount needed for growth and maintenance on a fat-free mass basis. This is not presumed to be the “optimal” level to improve overall metabolic health. Recent advances in measuring protein needs indicate current RDA underestimate actual protein needs by as much as 50% (Elango 2010, 2012).

A recent consensus position paper from the PROT-AGE Study Group proposed a daily protein intake 1.0 g/kg to support lean body mass and functional outcomes in older adults (Bauer 2013). Protein intakes moderately greater than the RDA may reduce the risk for chronic diseases such as obesity, cardiovascular disease, type 2 diabetes, and osteoporosis (Bauer 2013, Meckling 2007, Moughan, 2012) as well as assist with maintaining lean muscle mass which is particularly important for the elderly and those who are physically active/exercisers. Other experts recommend even higher protein intakes in the range of 1.1 to 1.5 g/kg/day to support better muscle and bone maintenance to help adults age well (Gaffney-Stromberg 2009 Paddon-Jones 2008). This in turn can improve strength and daily functioning, which is a critical consideration for reducing the risk of falls, fragility fractures and physical disability in aging populations.

Experts agree protein intakes much higher than current recommended dietary allowances (RDA) are needed for children's healthy growth and development, and that protein quality matters. Research shows that healthy 6 to 10 year old school aged children may require protein intakes of 1.3 to 1.55 g/kg/day for optimal growth and development (Elango 2011).

Protein can support a healthy weight and body composition:

Recent evidence supports higher-protein diets for both the prevention and treatment of overweight and obesity (Bopp 2008, Halton 2004, Weigle 2005; Westerterp-Plantenga 2009, Wycherley 2012). Higher protein energy restricted diets show greater weight loss, fat mass loss and perseveration of lean body mass compared to lower-protein energy restricted diets. Protein has a satiating effect, including greater perceived fullness and elevated satiety hormones after a higher protein meal. Those on research studies also show greater compliance to a higher-protein diet, supporting long term weight management.

Weight loss diets containing higher amounts of protein have been shown to be more effective compared to standard protein (higher carbohydrate) diets. The quantity of protein necessary to promote improved weight management lies somewhere between 1.2 and 1.6 g protein/kg/ day (approx. 89–119 g protein/d for females or approx. 104–138 g protein/d for males) (Layman 2005, Leidy 2007, Soenen 2013). Higher-protein diets that potentially include meal-specific protein quantities of at least approximately 25–30 g protein/meal provide improvements in appetite, body weight management, cardiometabolic risk factors, or all of these health outcomes (Leidy 2015). Results from several studies indicate that participants report greater overall satisfaction (greater palatability, pleasure, enjoyment) and/or motivation with higher vs. lower protein diets (Layman 2005, Leidy 2007, McConnon 2013).

One key factor in the effectiveness of higher protein meals/diets to decrease body weight is the improvement in appetite control and satiety, which may lead to decreased food consumption at later meals. Dietary protein increases satiety to a greater extent than dietary carbohydrate or fat. Protein also increases thermogenesis, which changes substrate oxidation and may, in turn, influence the appetitive signals that control food intake. A high protein diet has been hypothesised to modulate the release of hormones and neurochemicals in the gastrointestinal tract, which alters appetite and satiety, and ultimately regulates energy intake. These effects include decreasing levels of ghrelin (a hormone which stimulates hunger) and increasing the secretion of peptide YY and glucagon-like peptide-1 (hormones which reduce hunger).

Given the growing burden of obesity and related chronic diseases, it is also worth recognising the value of protein in promoting healthy weight. This population evidence is also consistent with findings from clinical trials examining the effects of higher dietary protein intakes on weight loss and weight maintenance. One study reported that satiety was markedly increased on a higher protein diet (30% of energy from protein) compared to an isocaloric standard protein diet (15% of total energy from protein) over two weeks (Weigle 2005). In the second phase of this study, an ad libitum higher protein diet (30% of energy from protein, 20% fat and 50% carbohydrate) resulted in a spontaneous decrease in energy intake of 441 kcal per day over 12 weeks. This sustained decrease in ad libitum caloric intake was accompanied by mean weight and fat loss of 4.9 kg and 3.7 kg, respectively.

In summary, higher-protein diets have shown to be a successful strategy to prevent or treat obesity due in part to modulations in energy metabolism, appetite, and energy intake (Leidy 2015). Recent evidence also supports higher-protein diets for improvements in cardiometabolic risk factors.

Other nutritional benefits of including lean red meat in our diet:

In addition to high quality protein, red meat contains important essential micronutrients including, iron, zinc, potassium, selenium and a range of B-vitamins including niacin, riboflavin, thiamine and vitamins B6 and B12.

Red meats contains useful amounts of the minerals selenium and potassium. Selenium acts as an antioxidant and is necessary for immune system function. Potassium plays an important role in blood pressure regulation. Red meats provide a range of B-vitamins including thiamine, niacin, riboflavin, pantothenic acid, and vitamins B6 and B12. B-vitamins play important roles in the functioning of the nervous system and in releasing energy from foods.

Contribution of meat and meat products to the average daily intake of magnesium is 15 %, 21 % for iron, 18 % for potassium and 36 % for zinc.

On average, in an 85-g cooked serving, lean beef contributes 45–62% (males–females) of the RDA for zinc, 91% for vitamin B12, 52% for selenium, 21% for phosphorous, 31–36% for niacin, 31% for vitamin B6, 27- 12% for iron, and 13–15% for riboflavin (McNeill 2013).

Certain amino acids and their benefits:

Leucine and muscle repair: leucine is a branch chain amino acid found in lean red meat. Leucine boosts muscle repair following resistance training.

Glutamine and the gastrointestinal tract: Glutamine is found in lean red meat, and dietary glutamine can maintain the health and integrity of the digestive tract.

Tryptophan and the brain: Lean red meat is a good source of tryptophan, which is responsible for synthesising serotonin, the feel-good hormone, which influences mood and mental health.

Vitamin B12:

Vitamin B12 is naturally occurring only in animal products (red meat, poultry, fish, eggs, and dairy products), B12 is an essential nutrient that it is important for healthy red blood cell formation, energy metabolism; development, myelination, and function of the central nervous system, and DNA synthesis.

Those most at risk of inadequate Vitamin B12 status are vegetarians/ vegans because plant foods do not contain vitamin B12 (however some breakfast cereals and nutritional yeasts are fortified with B12). Older adults and people with digestive tract conditions that affect the absorption of nutrients are also at risk of B12 deficiency. Research suggests that up to 90% of older adults have a vitamin B12 deficiency (Pawlak 2013).

Beef is one of the top food sources of vitamin B12. Vitamin B12 reduces the risk for developing megaloblastic anaemia and the irreversible neurologic disease caused by its deficiency.

Iron:

Iron is an important component of haemoglobin; haemoglobin is the protein molecule in red blood cells that carries oxygen from the lungs to the body's organs and tissues. If you don't have enough iron, your body cannot make enough healthy oxygen carrying red blood cells. Iron also improves oxygen storage through myoglobin, myoglobin transports and stores oxygen within your muscles. Iron is also important for cellular functioning and producing hormones. Iron also plays a role in immune health as it is essential for immune cells proliferation and maturation (Abbaspour 2013).

Lean red meat is one of the best sources of haem iron. Haem iron is more easily absorbed (more 'bioavailable') than non-haem iron which is found in plant-based foods. Additionally, a peptide, known as MFP factor, present in meat, fish and poultry enhances the absorption of non-haem iron present in the foods eaten at the same time as the meat, fish or poultry.

Eating too little iron increases your risk of Iron deficiency anaemia, which results in weakness, fatigue (tiredness and lack of energy), problems with concentration or memory and reduced immunity against viruses.

Single meal studies have shown that haem iron is more efficiently absorbed from the diet (20–30 %) than non-haem iron (5–15 %).

Zinc:

Lean red meat is good source of zinc, zinc helps build muscle mass, strengthens the immune system and helps promote a healthy brain. Zinc is an important co-factor for more than 100 enzymes involved in metabolic pathways, endocrine function, and immune integrity.

Zinc from animal sources is generally regarded as more bioavailable than zinc from plant based sources.

Zinc is essential for a healthy immune system, wound healing and for children's normal growth and reproductive development. Inadequate intakes of zinc (and iron) remain a concern for some population subgroups even in developed countries. In particular, infants, children and adolescents (particularly young females), women of childbearing age and older adults are more at risk of low iron and zinc intakes (Wyness 2011).

B Vitamins:

Red meat is a good source of niacin (B3) a B vitamin that supports good digestion. Red meat is also a good source of riboflavin (B2) a B vitamin that promotes healthy skin, eyes and converts food to energy. Red meat is also a good source of thiamine (B1) and B6.

Vitamin D:

The UK Scientific Committee for Nutrition review recommends a reference nutrient intake for vitamin D of 10 µg/d for the UK population aged 4 years and over (Scientific Advisory Committee on Nutrition 2015). Meat and meat products contribute 35% of vitamin D intake in teenagers (11–18 years) and 30 % in adults (19–64 years). It is thought that the vitamin D in meat is derived from the action of sunlight on the skin of animals or from the animals' feed. The vitamin D3 metabolite

25-hydroxycholecalciferol (25(OH)D3) is found in significant quantities in meat and is considered to have a high biological activity, resulting in better and faster absorption from the diet compared with its parent compound, cholecalciferol, vitamin D3. Data suggest that per microgram vitamin D compound consumed, 25(OH)D3 is approximately five times as effective as vitamin D3 in elevating serum 25(OH)D3 concentration. It has also been suggested that components of meat protein may enhance the utilisation of vitamin D in individuals, particularly where exposure to sunshine is limited. Vitamin D promotes calcium and phosphorous absorption, it is needed for bone growth and remodelling and development of teeth. It also facilitates normal immune system function. Most of New Zealand's population have vitamin D levels for at least part of the year that are considered insufficient (Bolland 2012).

Women's health:

Health messages to lower red meat intakes could have adverse implications on the micronutrient quality of women's diets. Females consuming less than 40 g total red meat daily were more likely to have micronutrient intakes below the Lower Reference Nutrient Intake (LRNI) for zinc, iron, vitamin B12 and potassium and have lower habitual vitamin D intakes than females consuming between 40 and 69 g daily (Derbyshire 2017).

Females are at particularly high risk of iron deficiency (ID) and iron deficiency anaemia (IDA). ID is characterised by diminished iron stores whilst IDA is attributed to the combined effects of poor iron stores and diminished haemoglobin levels (McClung 2013). Menstruation, blood donation, diets of low iron bioavailability and the physiological demands of pregnancy all take their toll on female's iron stores (Coad 2011). Iron is also critical to reproductive health, with IDA having wide-ranging detrimental effects on maternal and infant well-being. Some research has also linked ID in females of childbearing age to reduced cognition, mental health and heightened fatigue.

With regard to zinc, the human genome encodes around 3000 different zinc proteins, each playing key roles at the cellular level, with the impact of zinc on health and disease thought to be as far-reaching as iron (Maret 2013). Zinc has an important role on women's bone health, the immune system, and acts as an antioxidant and anti-inflammatory agent.

Alongside iron and zinc, lean red meat is also an excellent provider of vitamin B12, niacin, vitamin B6, phosphorous and source of riboflavin, pantothenic acid, and some vitamin D (Williams 2007). B-vitamins perform essential roles in cell function, acting as co-enzymes and having potential roles in brain health, protection against osteoporosis, especially amongst those with malabsorption conditions such as coeliac disease [13].

Suboptimal vitamin D status amongst women has been linked to impaired fertility, endometriosis and polycystic ovary syndrome, alongside being associated with higher rates of preeclampsia, preterm births, bacterial vaginosis and gestational diabetes, as evidenced by observational studies (Grundmann 2011). Given the nutrients that red meat can provide, it has potential to play an important role in supporting women's health and general wellbeing.

UK women consuming <40g daily total red meat were four times more likely to have zinc intakes below LRNI compared to those eating between 40 g and 69 g daily. Eating less than 40 g red meat daily significantly reduced UK women's vitamin D intakes from dietary sources. It should be considered that zinc is an important nutrient for women of reproductive age. This can be obtained successfully from dietary sources including red meat provided that these are consumed in adequate amounts. Recent work has identified a significant relationship between serum zinc levels and symptoms of premenstrual syndrome amongst a sample of 48 young girls (Fathizadeh 2016).

In 2010, the Scientific Advisory Committee on Nutrition also proposed that "A recommendation to reduce consumption of red and processed meat in order to decrease colorectal cancer risk could have a negative impact on iron and zinc intakes in the UK by increasing the proportion of the population with intakes below the LRNIs for these nutrients".

Red meat and athletes:

Three to four servings of red meat per week should be enough to meet an athlete's dietary needs.

Excellent source of high quality bioavailable complete protein (provides all essential amino acids). Protein is essential for repairing tissues/ muscle mass, recovery and performance. Protein also plays an important role in supporting an athlete's immune system.

Protein keeps us feeling fuller for longer and more satisfied which can support weight management if that is a goal of the athlete.

Red meat is a rich source of many micronutrients including iron, zinc, Vitamin B12, B3, B6, and phosphorous.

Research shows that athletes need 30% more iron than non-athletes. An estimated 30% of male athletes and 80% of female athletes may be iron deficient. Red meat is a great source of iron, which is essential in the production of haemoglobin. Haemoglobin is the protein in red blood cells which binds with oxygen and transports oxygen (fuel source) around the body. Research has shown that stage 2 and stage 3 iron deficiency will impair physical performance.

Red meat and older adults:

The protein you get from red meat contains all the amino acids necessary for building and repairing muscles. Some research suggests that you lose 3 to 5% of your muscle mass as you get older, this is known as sarcopenia. Maintaining muscle mass as we age is critical in reducing the risk of injuries and falls and is necessary to maintain the quality of life associated with adequate muscle mass and strength. Current protein recommendations may not be sufficient to prevent sarcopenia in elderly people. Protein maintains or increases fat-free mass by favouring a stimulatory effect on muscle protein anabolism (Churchward-Venne 2013, Paddon-Jones 2008). The branched chain amino acids (leucine, isoleucine, and valine) are the essential amino acids needed for protein synthesis. Branched-chain amino acids are generally higher in animal proteins than plant proteins and are highest in red meat. An examination of elderly women showed that resistance training combined with lean red meat consumption resulted in greater gains in total body lean tissue mass, leg lean tissue mass, and muscle strength compared to a control diet (pasta/rice) combined with resistance training (Daly 2014). Comparing beef versus soy, another study found greater myofibrillar protein synthesis at rest and after performance of resistance exercise with beef (Phillips 2012).

Red meat versus processed red meat:

An observation study showed that higher PRM (processed red meat) consumption was associated with significantly higher BMI and hip circumference in men, and higher TC, LDL-C, HbA1c and PP (pulse pressure) in women, which was not observed for RM (red meat) consumption. Fewer adults in the highest tertile of TRPRM intake were below lower reference nutrient intakes (LRNIs), particularly for zinc and iron, respectively Hobbs-Grimmer 2021).

Changes to dietary habits over time:

In recent history, replacement of unprocessed or minimally processed foods (such as meat, milk, eggs, vegetables, fruit, nuts and seeds) with ultra-processed ready-to-consume food products including oils and shortenings and refined wheat flour, as well as soft drinks have occurred. These changes in food consumption patterns and trends in obesity during the same period raise important concerns about the prevention of obesity and chronic diseases.

Health promotion diets emphasise minimally processed foods such as vegetables and fruit, whole grains, milk products, lean meats, poultry, fish, eggs, legumes and nuts and seeds. This way of eating gets back to the basics of encouraging a more traditional, balanced and healthy way of eating. This type of approach to dietary guidance results in diets naturally lower in salt, trans fat, saturated fat, added sugar and refined carbohydrates and higher in fibre, unsaturated fats, minerals, antioxidants and phytochemicals (Mozaffarian 2010). This type of positive guidance can also lead to diets that are naturally more satiating and lower in energy (Miller et al 2009). Ultimately, this type of approach is likely to prove much more effective for promoting weight management and reducing risk factors that contribute to the burden of chronic diseases such as heart disease, stroke, diabetes and cancer.

The findings of the Global Burden of Disease Study (Lim 2012), the largest systematic review to estimate the contribution of risk factors to disease and disability to date reported a diet high in red meat was ranked the lowest in a list of 43 factors contributing to the global burden of disease. This study provides valuable insight to inform priorities for dietary guidance and disease prevention in an evidence-based manner.

References:

Maki K, Wilcox M, Dicklin M, Buggia M, Palacios O, Maki C, Kramer M. Substituting Lean Beef for Carbohydrate in a Healthy Dietary Pattern Does Not Adversely Affect the Cardiometabolic Risk Factor Profile in Men and Women at Risk for Type 2 Diabetes. Jn of Nutr Disease 2020 May 2. doi: https://doi.org/10.1093/jn/nxaa116.

Pan A, Sun Q, Bernstein AM, Schulze MB, Manson JE, Willett WC, Hu FB. Red meat consumption and risk of type 2 diabetes: 3 cohorts of US adults and an updated meta-analysis. Am J Clin Nutr 2011;94(4):1088– 96.

Vernooij RWM, Zeraatkar D, Han MA, El Dib R, Zworth M, Milio K, Sit D, Lee Y, Gomaa H, Valli C, et al. Patterns of red meat and processed meat consumption and risk for cardiometabolic and cancer outcomes: a systematic review and meta-analysis of cohort studies. Ann Intern Med 2019[Epub ahead of print2019 Oct 1. doi:10.7326/M19-1583].

Turner KM, Keogh JB, Clifton PM. Red meat, dairy, and insulin sensitivity: a randomized crossover intervention study. Am J Clin Nutr 2015;101(6):1173–9.

Roussell MA, Hill AM, Gaugler TL, West SG, Heuvel JP, Alaupovic P, Gillies PJ, Kris-Etherton PM. Beef in an Optimal Lean Diet study: effects on lipids, lipoproteins, and apolipoproteins. Am J Clin Nutr 2012;95(1):9–16.

Guasch-Ferré M, Satija A, Blondin SA, Janiszewski M, Emlen E, O'Connor LE, Campbell WW, Hu FB, Willett WC, Stampfer MJ. Meta-analysis of randomized controlled trials of red meat consumption in comparison with various comparison diets on cardiovascular risk factors. Circulation 2019;139(15):1828–45.

Fleming J, Kris-Etherton P, Petersen K, Baer D. Effect of varying quantities of lean beef as part of a Mediterranean-style dietary pattern on lipids and lipoproteins: a randomized crossover controlled feeding trial. Am J Clin Nutr 2021; 113:1126–1136.

O'Connor LE, Paddon-Jones D, Wright AJ, Campbell WW. A Mediterranean-style eating pattern with lean, unprocessed red meat has cardiometabolic benefits for adults who are overweight or obese in a randomized, crossover, controlled feeding trial. Am J Clin Nutr 2018;108(1):33–40.

Zheng Y, Li Y, Satija A, Pan A, Sotos-Prieto M, Rimm E, Willett WC, Hu FB. Association of changes in red meat consumption with total and cause specific mortality among US women and men: two prospective cohort studies. BMJ 2019;365:l2110.

Bechthold A, Boeing H, Schwedhelm C, Hoffmann G, Knuppel S, Iqbal K, De Henauw S, Michels N, Devleesschauwer B, Schlesinger S, et al. Food groups and risk of coronary heart disease, stroke and heart failure: a systematic review and dose-response meta-analysis of prospective studies. Crit Rev Food Sci Nutr 2019;59(7):1071–90.

Roussell MA, Hill AM, Gaugler TL, West SG, Ulbrecht JS, Vanden Heuvel JP, Gillies PJ, Kris-Etherton PM. Effects of a DASH-like diet containing lean beef on vascular health. J Hum Hypertens 2014;28(10):600–5.

McNeill S. Inclusion of red meat in healthful dietary patterns. Meat Science 2014; 98: 452-460.

Astrup A, Dyerberg J, Elwood P, Hermansen K, Hu F, Jakobsen M, Kok F, Krauss R, Lecerf J, LeGrand P, Nestel P, Risérus U, Sanders T, Sinclair A, Stender S, Tholstrup T, Willett, W. 2011. The role of reducing intakes of saturated fat in the prevention of cardiovascular disease: Where does the evidence stand in 2010? American Journal of Clinical Nutrition, 93(4), 684–688, http://dx.doi. org/10.3945/ajcn.110.004622.

Baum S, Kris-Etherton P, Willett W, Lichtenstein A, Rudel L., Maki K et al 2012. Fatty acids in cardiovascular health and disease: A comprehensive update. Journal of Clinical Lipidology, 6(3), 216–234, http://dx. doi.org/10.1016/j.jacl.2012.04.077.

Bopp, M. J., Houston, D. K., Lenchik, L., Easter, L., Kritchevsky, S. B., & Nicklas, B. J. (2008). Lean mass loss is associated with low protein intake during dietary-induced weight loss in postmenopausal women. Journal of the American Dietetic Association, 108(7), 1216–1220, http://dx.doi.org/10.1016/j.jada.2008.04.017.

Halton, T. L., & Hu, F. B. (2004). The effects of high protein diets on thermogenesis, satiety and weight loss: A critical review. Journal of the American College of Nutrition, 23(5), 373–385.

Westerterp-Plantenga, M. S., Nieuwenhuizen, A., Tome, D., Soenen, S., & Westerterp, K. R. (2009). Dietary protein, weight loss, and weight maintenance. Annual Review of Nutrition, 29, 21–41, http://dx.doi.org/10.1146/annurev-nutr-080508-141056.

Wycherley, T. P., Moran, L. J., Clifton, P. M., Noakes, M., & Brinkworth, G. D. (2012). Effects of energy-restricted high-protein, low-fat compared with standard-protein, low-fat diets: A meta-analysis of randomized controlled trials. American Journal of Clinical Nutrition, 96(6), 1281–1298, http://dx.doi.org/10.3945/ajcn.112.044321.

Layman, D. K., Evans, E., Baum, J. I., Seyler, J., Erickson, D. J., & Boileau, R. A. (2005). Dietary protein and exercise have additive effects on body composition during weight loss in adult women. Journal of Nutrition, 135(8), 1903–1910.

Leidy, H. J., Carnell, N. S., Mattes, R. D., & Campbell, W. W. (2007). Higher protein intake preserves lean mass and satiety with weight loss in pre-obese and obese women. Obesity (Silver Spring), 15(2), 421–429, http://dx.doi.org/10.1038/oby.2007.531.

Soenen, S., Martens, E. A., Hochstenbach-Waelen, A., Lemmens, S. G., & WesterterpPlantenga, M. S. (2013). Normal protein intake is required for body weight loss and weight maintenance, and elevated protein intake for additional preservation of resting energy expenditure and fat free mass. Journal of Nutrition, 143(5), 591–596, http://dx.doi.org/10.3945/jn.112.167593.

McConnon, A., Horgan, G. W., Lawton, C., Stubbs, J., Shepherd, R., Astrup, A., …, & Raats, M. M. (2013). Experience and acceptability of diets of varying protein content and glycemic index in an obese cohort: Results from the Diogenes trial. European Journal of Clinical Nutrition, 67(9), 990–995, http://dx.doi.org/10.1038/ejcn.2013.99.

Churchward-Venne, T. A., Murphy, C. H., Longland, T. M., & Phillips, S. M. (2013). Role of protein and amino acids in promoting lean mass accretion with resistance exercise and attenuating lean mass loss during energy deficit in humans. Amino Acids, 45(2), 231–240, http://dx.doi.org/10.1007/s00726-013-1506-0.

Paddon-Jones, D., Short, K. R., Campbell, W. W., Volpi, E., & Wolfe, R. R. (2008). Role of dietary protein in the sarcopenia of aging. American Journal of Clinical Nutrition, 87(5), 1562S–1566S.

Daly, R. M., O'Connell, S. L., Mundell, N. L., Grimes, C. A., Dunstan, D. W., & Nowson, C. A. (2014). Protein-enriched diet, with the use of lean red meat, combined with progressive resistance training enhances lean tissue mass and muscle strength and reduces circulating IL-6 concentrations in elderly women: A cluster randomized controlled trial. American Journal of Clinical Nutrition, 99(4), 899–910, http://dx.doi.org/10. 3945/ajcn.113.064154.

Phillips, S. M. (2012). Nutrient-rich meat proteins in offsetting age-related muscle loss. Meat Science, 92(3), 174–178, http://dx.doi.org/10.1016/j.meatsci.2012.04.027.

McNeill, S., Lofgren, P., & Van Elswyk, M. (2013). The role of lean beef in healthful dietary patterns. Myth versus reality. Nutrition Today, 48, 181–188.

Derbyshire E. Associations between Red Meat Intakes and the Micronutrient Intake and Status of UK Females: A Secondary Analysis of the UK National Diet and Nutrition Survey. Nutrients 2017, 9, 768; doi:10.3390/nu9070768.

McClung, J.P.; Murray-Kolb, L.E. Iron nutrition and premenopausal women: Effects of poor iron status on physical and neuropsychological performance. Annu. Rev. Nutr. 2013, 33, 271–288.

Coad, J.; Conlon, C. Iron deficiency in women: Assessment, causes and consequences. Curr. Opin. Clin. Nutr. Metab. Care 2011, 14, 625–634.

Maret, W. Zinc biochemistry: From a single zinc enzyme to a key element of life. Adv. Nutr. 2013, 4, 82–91.

Williams, P. Nutritional composition of red meat. Nutr. Diet. 2007, 64, S113–S119.

Grundmann, M.; von Versen-Hoynck, F. Vitamin D—Roles in women's reproductive health? Reprod. Biol. Endocrinol. 2011, 9, 146.

Fathizadeh, S.; Amani, R.; Haghighizadeh, M.H.; Hormozi, R. Comparison of serum zinc concentrations and body antioxidant status between young women with premenstrual syndrome and normal controls: A case-control study. Int. J. Reprod. Biomed. 2016, 14, 699–704.

SACN: Iron and Health. Available online: http://www.fcrn.org.uk/sites/default/files/sacn_iron_and_health_report.pdf.

Hobbs-Grimmer D, Givens D, Lovegrove J. Associations between red meat, processed red meat and total red and processed red meat consumption, nutritional adequacy and markers of health and cardio-metabolic diseases in British adults: a cross-sectional analysis using data from UK National Diet and Nutrition Survey. European Journal of Nutrition (2021) 60:2979–2997.

O'Connor LE, Kim JE, Campbell WW (2017) Total red meat intake of ≥0.5 servings/d does not negatively infuence cardiovascular disease risk factors: a systemically searched meta-analysis of randomized controlled trials. Am J Clin Nutr 105:57–69.

Celada, P.; Sánchez-Muniz, F.J. Are meat and meat product consumptions harmful? Their relationship with the risk of colorectal cancer and other degenerative diseases. An. Real Acad. Nac. Farm. 2016, 82, 68–90.

Micha R, Michas G, Mozaffarian D. Unprocessed red and processed meats and risk of coronary artery disease and type 2 diabetes—an updated review of the evidence. Curr Atheroscler Rep 2012;14(6):515– 24.

O'Connor LE, Kim JE, Campbell WW. Total red meat intake of ≥0.5 servings/d does not negatively influence cardiovascular disease risk factors: a systemically searched meta-analysis of randomized controlled trials. Am J Clin Nutr 2017;105(1):57–69.

US Department of Agriculture and Department of Health and Human Services. Scientific report of the 2015 Dietary Guidelines Advisory Committee. February 2015. Available from: https://health.gov/dietaryguidelines/2015-scientific-report/PDFs/ScientificReport-of-the-2015-Dietary-Guidelines-Advisory-Committee.pdf.

Micha, R., Wallace, S. K., & Mozaffarian, D. (2010). Red and processed meat consumption and risk of incident coronary heart disease, stroke, and diabetes mellitus: A systematic review and meta-analysis. Circulation, 121, 2271–2283.

Wyness, L., Weichselbaum, E., O'Connor, A., Williams, E. B., Benelam, B., Riley, H., & Stanner, S. (2011). Red meat in the diet: An update. British Nutrition Foundation Nutrition Bulletin, 36, 34–77.

Kappeler, R., Eichholzer, M., & Rohrmann, S. (2013). Meat consumption and diet quality and mortality in NHANES III. European Journal of Clinical Nutrition, 67, 598–606.

Rohrmann, S., Overvad, K., Bueno-de-Mesquita, H. B., Jakobsen, M. U., Egeberg, R., Tjønneland, A., et al. (2013). Meat consumption and mortality — Results from the European prospective investigation into cancer and nutrition. BMC Medicine, 11, 63.

Slater, J., Green, C. G., Sevenhuysen, G., Edginton, B., O'Neil, J., & Heasman, M. (2009). The growing Canadian energy gap: More the can than the couch? Public Health Nutrition, 12, 2216–2224.

Kris-Etherton, P.M., & Yu, S. (1997). Individual fatty acid effects on plasma lipids and lipoproteins: Human studies. American Journal of Clinical Nutrition, 65, S1628–S1644.

Mensink, R. P., Zock, P. L., Kester, A.D., & Katan, M. B. (2003). Effects of dietary fatty acids and carbohydrates on the ratio of serum total to HDL cholesterol and on serum lipids and apolipoproteins: A meta-analysis of 60 controlled trials. American Journal of Clinical Nutrition, 77, 1146–1155.

Elango, R., Ball, R. O., & Pencharz, P. B. (2012). Recent advances in determining protein and amino acid requirements in humans. British Journal of Nutrition, 108, S22–S30.

Elango, R., Humayun, M.A., Ball, R. O., & Pencharz, P. B. (2010). Evidence that protein requirements have been significantly underestimated. Current Opinion in Clinical Nutrition and Metabolic Care, 13, 52–57.

Chowdhury, R., Warnakula, S., Kunutsor, S., Crowe, F., Ward, H. A., Johnson, L., et al. (2014). Association of dietary, circulating, and supplement fatty acids with coronary risk: A systematic review and meta-analysis. Annals of Internal Medicine, 160, 398–406.

Danaei, G., Ding, E. L., Mozaffarian, D., Taylor, B., Rehm, J., Murray, C. J. L., et al. (2009). The preventable causes of death in the United States: Comparative risk assessment of dietary, lifestyle, and metabolic risk factors. PLoS Medicine, 6e1000058, 1–23.

Mozaffarian, D., & Ludwig, D. S. (2010). Dietary guidelines in the 21st century — A time for food. Journal of the American Medical Association, 304, 681–682.

Lim, S. S., Vos, T., Flaxman, A.D., Danaei, G., Shibuya, K., Adair-Rohani, H., et al. (2012). A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: A systematic analysis for the Global Burden of Disease Study 2010. The Lancet, 380, 2224–2260.

Scientific Advisory Committee on Nutrition (2015) Draft Vitamin D and Health Report. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/447402/Draft_SACN_Vitamin_D_and_Health_ Report.pdf

Davidson, M. H., Hunninghake, D., Maki, K. C., Kwiterovich, P. O., Jr., & Kafonek, S. (1999). Comparison of the effects of lean red meat vs lean white meat on serum lipid levels among free-living persons with hypercholesterolemia: A long-term, randomized clinical trial. Archives of Internal Medicine, 159(12), 1331–1338.

Li, D., Siriamornpun, S., Wahlqvist, M. L., Mann, N. J., & Sinclair, A. J. (2005). Lean meat and heart health. Asia Pacific Journal of Clinical Nutrition, 14(2), 113–119.

Hodgson, J. M., Burke, V., Beilin, L. J., & Puddey, I. B. (2006). Partial substitution of carbohydrate intake with protein intake from lean red meat lowers blood pressure in hypertensive persons. American Journal of Clinical Nutrition, 83(4), 780–787.

Bauer, J., Biolo, G., Cederholm, T., Cesari, M., Cruz-Jentoft, A. J., Morley, J. E., Phillips, S., Sieber, C., Stehle, P., Teta, D., Visvanathan, R., Volpi, E., & Boirie, Y. (2013). Evidencebased recommendations for optimal dietary protein intake in older people: A position paper from the PROT-AGE Study Group. Journal of the American Medical Directors Association, 14, 542–559.

Meckling, K. A., & Sherfey, R. (2007). A randomized trial of a hypocaloric high-protein diet, with and without exercise, on weight loss, fitness, and markers of the Metabolic Syndrome in overweight and obese women. Applied Physiology, Nutrition and Metabolism, 32(4), 743–752, http://dx.doi.org/10.1139/H07-059.

Moughan, P. J. (2012). Dietary protein for human health. British Journal of Nutrition, 108(Suppl. 2), S1–S2, http://dx.doi.org/10.1017/S0007114512003509.

Gaffney-Stomberg, E., Insogna, K. L., Rodriguez, N. R., & Kerstetter, J. E. (2009). Increasing dietary protein requirements in elderly people for optimal muscle and bone health. Journal of the American Geriatrics Society, 57(6), 1073–1079, http://dx.doi.org/10. 1111/j.1532-5415.2009.02285.x.

Elango, R., Ball, R. O., Humayun, M.A., & Pencharz, P. B. (2011). Protein requirement of healthy school-age children determined by the indicator amino acid oxidation method. American Journal of Clinical Nutrition, 94, 1545–1552.

Weigle, D. S., Breen, P. A., Matthys, C. C., Callahan, H. S., Meeuws, K. E., Burden, V. R., & Purnell, J. Q. (2005). 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, 82, 41–48.

Layman, D. K., Clifton, P., Gannon, M. C., Krauss, R. M., & Nuttall, F. Q. (2008). Protein in optimal health: Heart disease and type 2 diabetes. American Journal of Clinical Nutrition, 87, S1571–S1575.

Nuttall, F. Q., Schweim, K., Hoover, H., & Gannon, M. C. (2008). Effect of the LoBAG30 diet on blood glucose control in people with type 2 diabetes. British Journal of Nutrition, 99, 511–519.

Leidy, H, Clifton P, Astrup A, Wycherley T, Westerterp-Plantenga M, Luscombe-Marsh N, Woods S, Mattes R. The role of protein in weight loss and maintenance. Am J Clin Nutr 2015;101(Suppl):1320S–9S.

Pawlak, R, Parrott S, Raj S, Cullum-Dugan D, Lucus D. How prevalent is vitamin B12 deficiency among vegetarians? Nutrition Reviews 2013; Vol. 71(2):110–117.

Abbaspour N, Hurrell R, Kelishadi. Review on iron and its importance for human health. J Res Med Sci 2014;19:164-74.

Bolland, M, Grey A, Davidson J, Cundy T, Reid I. Should measurement of vitamin D and treatment of vitamin D insufficiency be routine in New Zealand? N Z Med J**.** 2012 Feb 10;125(1349):83-91.

Additional Sources & References used in Social Media Activity

The Role of Red Meat in a healthy New Zealand diet – Beef and Lamb NZ, 2015

Dietary Fat – Red Meat’s contribution – Beef and Lamb NZ, 2013

Beefandlambnz.com/the-life/grass-fed-beef-lamb-nutrition-benefits

Perfectketo.com/benefits-of-grass-fed-beef

How does red meat fit into today's diet – Beef and Lamb NZ, 2015