**Regeneratively-Raised Animal-Sourced Foods in the Prevention and Treatment of**

**Metabolic Dysfunction in Obese Adults**

It is well known the rates of obesity and chronic disease have been on the rise for decades and these symptoms of underlying metabolic dysfunction (MD) will continue to rise if we fail to address this epidemic. While there are a variety of factors associated with poor metabolic health, one of the most important and controversial topics is nutrition. Many nutritional recommendations have been made to reduce the risk of MD, unfortunately success has been limited. While excess calories, carbohydrates, and saturated fats have been demonized as the drivers of MD, as with most things, the devil is in the details. Limited carbohydrate, versus fat and protein, during human evolution is intricately connected to the risk of type-II diabetes (T2D) (Brand-Miller, et. al., 2012). Polyunsaturated vegetable seed oils, such as linoleic acid (LA), appear to be a major player in our obesogenic environment, while saturated fats such as stearic acid have actually been shown to decrease cardiovascular and cancer risk, significantly reduce visceral adipose tissue, and prevent elevations in blood glucose independently of weight loss (Shen, et. al., 2014; Senyilmaz-Tiebe, et. al., 2018). This paper will build on previous research that has identified the potential benefits and limitations of animal-sourced food (ASF) inclusive nutrition. The purpose of this paper is to identify the specific nutritional benefits to regeneratively-raised ASF for the prevention and treatment of MD in obese adults.

**Prevalence of Metabolic Disorders**

According to the National Heart, Lung, and Blood Institute (NHLBI), metabolic syndrome (MS) is the term for a set of five potential risk factors (conditions, traits, or habits) that raise your risk for a number of chronic diseases such as heart disease, diabetes, and stroke. As of 2016, the incidence of MD in American adults is dangerously high at 88% (Araújo, Cai, & Stevens, 2019). We must first differentiate the two disorders: MD is defined as having only one of the five risk factors either too high or too low whereas a MS diagnoses requires three or more being out of the suggested range. It is important to note that taking medication for any of the associated risk factors automatically qualifies as a risk factor, regardless if numbers are within recommended ranges.

Optimal metabolic health consists of the following:

* triglycerides < 150 mg/dL,
* HDL (the so-called “good” cholesterol) > 40 mg/dL for men and 50 mg/dL for women,
* blood pressure < 120/80,
* blood glucose < 100 mg/dL and hemoglobin A1C < 5.7%, and
* a waist circumference below 40 inches for men and below 34.6 inches for women.

**Polyunsaturated Fat**

In 1993, Health and Human Services established the Dietary Guideline Advisory Committee (DGAC) who placed the first recommendations on total and saturated fat consumption of 35% and 10% respectively. In the following years, the Food Guide Pyramid and subsequent MyPlate update both placed restrictions and limitations on red meat and cheese due to their high saturated fat content while placing an emphasis on the consumption of unsaturated fat such as highly refined and oxidized vegetable seed oils. Recently, renowned nutritionists called for an immediate update of the 2020 US dietary guidelines for publishing by year end and former members of the DGAC have requested the departments of agriculture and health and human services to seriously consider removing the limit put on dietary saturated fat as they conclude that “there is no strong scientific evidence that the current population-wide upper limits on commonly consumed saturated fats in the US will prevent cardiovascular disease or reduce mortality and a continued limit on these fats is not justified (Demasi, 2020).” Although research has shown that saturated fat increases low density lipoprotein (LDL) (once thought of as “bad” cholesterol), its relationship with cardiovascular disease risk, initially proposed and popularized by the 1958 Ancel Keys Seven Countries Study, is only correlative and certainly controversial.

The most plentiful polyunsaturated fatty acid in current industrialized nutrition is LA, making up anywhere between three to sometimes >17% of energy consumption (%E) in people globally with evolutionary and historical averages ranging from 2-3%E (Ramsden, et al., 2018). Although approximately 0.5%E is required for its role as an essential fatty acid (EFA), we are consuming on average 10 times that necessary for function. While LA is an integral part of the human body, it is also a direct predecessor to bioactive oxidized LA metabolites (OXLAMs) and are associated with pathological issues stemming from chronic pain to cardiovascular disease (Ramsden, et al., 2012). Alzheimer’s dementia, recently referred to as type 3 diabetes, and non-alcoholic steatohepatitis patients have elevated plasma OXLAMs, which have been suggested as biomarkers indicative of the presence of either condition (Ramsden, et al., 2012). OXLAMs, along with reactive aldehydes such as 4-hydroxy-2-nonenal (4-HNE), exist in heated seed oils and can be endogenously created after intake of LA (Ramsden, et al., 2018). 4-HNE rises in response to oxidative stress and is known to result in pathology and malfunction in multiple cells in times of oxidative stress (Dasuri, et al., 2013). This data indicates that reducing LA consumption can lower the creation and/or collection of oxidized LA by-products which are intertwined with a multitude of pathological conditions related to MD (Ramsden, et al., 2012). This is important as cognitive impairment is on the rise and has a serious impact on those who suffer from the related diseases as well as those who care for the diseased.

While it hasn’t yet been connected to the global obesity epidemic, endocannabinoid (ECB) hyperactivity is suspected to act as a precursor to obesity in multiple organs. Researchers found LA 8%E, in comparison with their established evolutionary consistent 1%E, to result in the onset of nutritionally generated obesity in mice (Alvheim, et al., 2012). They also found that by combining 1%E with long-chain omega-3 fat (DHA & EPA) to the 8%E LA nutrition ended with metabolic patterns mirroring the 1%E LA nutrition and selectively lowering LA to 1%E transposed the obesogenic qualities of 60%E fat nutrition (Alvheim, et al., 2012). This mouse model closely resembled the 20th century rise of human LA intake, modifications which intimately coincide with the rising prevalence of obesity (Alvheim, et al., 2012). Clearly there’s a biological role for EPA and DHA for brain maturation, but is it possible we may not require as much to live healthfully during adulthood in the context of a diet consisting of the evolutionary consistent 1-3%E LA? Either way, this declares the importance for long-chain omega-3 sources from ASF. Furthermore, adequate dietary arachidonic acid (AA) from ASF should negate the necessity for AA synthesis from LA which theoretically should circumvent the excessive LA associated consequences. Researchers believe that correcting the precursor to ECB over-stimulus could be a feasible and harmless possibility towards obesity reduction and prevention.

**Saturated Fat**

In the last 40 years foods with lower saturated fatty acids (SFA) have been suggested to reduce cholesterol levels and thus heart disease risk. In spite of the US reducing its consumption of whole fat milk by over 75% during the 20 year period following this suggestion, the prevalence of MS has continued to rise (Venn-Watson, et. al., 2020). Furthermore, studies have shown associations between higher consumption of full-fat dairy and reduced risk of cardiovascular disease and T2D (Venn-Watson, et. al., 2020). Dairy and fish contain trace amounts of odd-chain saturated fatty acids (OCFA’s). Elevated systemic concentrations of OCFA’s pentadecanoic acid (C15:0) and heptadecanoic acid (C17:0) have been connected with reduced cardio-metabolic diseases and increased consumption of OCFA’s is linked to lower mortality (Venn-Watson, et. al., 2020). C15:0 is shown as a dietary fatty acid that reduces dyslipidemia, inflammation, anemia, cardiovascular disease, T2D, chronic obstructive pulmonary disease (COPD), pancreatic cancer, MS, nonalcoholic steatohepatitis, fibrosis, and other related conditions possibly by binding to crucial metabolic controllers and restoring mitochondrial function (Venn-Watson, et. al., 2020). Epidemiological studies supply evidence of links between OCFA’s and improved health, but there are limited controlled studies assessing direct health outcomes (Venn-Watson, et. al., 2020). Further research is needed to determine if OCFA’s are potential essential fatty acids of which recent reduction may have led to possible deficiencies and susceptibility to MS. This data suggests that those choosing to to omit the consumption of ASF may be limiting their metabolic function potential.

Stearic acid (C18:0) is a long-chain SFA found in large concentrations in whole ASF. It acts as a dietary metabolite that is sensed by the body to regulate mitochondria, which may explain part of the epidemiological variance between palmitic acid (C16:0) and C18:0 as C16:0 increases cardiovascular and cancer risk while C18:0 decreases both (Senyilmaz-Tiebe, et. al., 2018). Food modernization has provided humans with sources comparatively high in single metabolites such as C16:0 and it is crucial to comprehend the metabolites sensed by the body along with their physiological responses. In a double-blind crossover clinical study, researchers found 90% of participants experienced mitochondrial fusion with 24 grams of C18:0 within three hours of consumption (Senyilmaz-Tiebe, et. al., 2018). Researchers also found that C18:0 consumption lowered metastasis tumor risk in athymic nude mice so they hypothesize that dietary C18:0 may reduce VAT. Further research found that C18:0 consumption results in a significant reduction in VAT probably caused by the apoptosis of preadipocytes (Shen, et. al., 2014). While investigations of possible actions of C18:0 inhibiting metastasis are ongoing, they have yet to be shown in humans (Shen, et. al., 2014). Future research is needed around the results of the consumption of C18:0 on diabetes, CVD, and MS in addition to certain cancers. The high levels of C18:0 contained in most ASF appears to reduce VAT and prevent and possibly reverse various disease processes in mammals. Other than the C18:0 rich plant food cacao, ASF are generally higher in C18:0 than C16:0, which suggests that ASF may contribute more to mitochondria health than that of typical lesser containing plant foods.

**Protein**

The recommended dietary allowance (RDA) for protein is set at a modest 0.8 g/kg bodyweight, but the definition of RDA is “the amount of a nutrient you need to meet your basic nutritional needs,” which does not account for any lifestyle factors or diseases that may require more protein such as in athletes of any sort or for satiety in the obese. The National Academy of Sciences recently proposed the “Acceptable Macronutrient Distribution Ranges” for protein to be 10-35% of total calories, which comes out to be 1.5-2.2 g/kg daily, at least double the RDA (Pencharz, et. al., 2016). Unfortunately some people are not meeting the 50 grams of protein daily necessary to meet the RDA based on a 2000 calorie diet and rarely is someone consuming it in the optimal range of closer to about 100 grams. It is no wonder why so many people struggle with fat loss. Of course, these numbers do not reflect the type of protein necessary to stimulate muscle protein synthesis (MPS), and since the recent mainstream narrative has been a largely plant-based approach to nutrition most people are not consuming enough of the essential amino acids abundantly contained in ASF, which are required in certain quantities to stimulate MPS. If you do not stimulate MPS through nutrition and resistance training, it is nearly impossible to gain LBM and more difficult to use energy efficiently via disposal into working muscles making fat loss more difficult. The protein leverage hypothesis (PLH) states that one factor is a reduction in the portion of protein within our nutrition, which, as a result of the leveraging effects of protein, ends in increased total food consumption and as a result excess calories (Hill & Morrison, 2019). Research suggests that even partial protein leverage may participate as a crucial component of the continual increase in obesity. Further studies are needed to explore the actions that underpin protein recognition and influence because understanding the biological mechanisms could enhance our knowledge of why, when, and how protein consumption affects health. A multitude of cellular and endocrine detectors have been connected with protein sensing, but more research is needed to assess how these different pathways connect to modify behavior around food consumption and/or metabolism and specifically if these mechanisms result in diverse protein influence.

**Conclusion**

A variety of possible causes for the recent rise in MD and obesity exist. Understanding the reasons why changes in dietary consumption and nutrition composition stimulate ease or disease has been an ongoing aim amongst scientists, the obese, and the diseased alike. The US DGAC recommendations to reduce dietary saturated fats, specifically those from ASF, and increase dietary unsaturated fats, specifically those from vegetable seed oils, has led to an evolutionary inconsistent nutritional paradigm and subsequent catastrophic consequences to human and animal health. Furthermore, this epidemic has spread across much of the industrialized world since many countries tend to follow the US nutritional guidelines. IR, T2D, and obesity are problematic with groups who rapidly convert from human evolutionary nutrition containing low-glycemic foods to high-glycemic and high carbohydrate nutrition which are like the current standard American diet (SAD). It is important to remember that protein and fat are essential nutrients, while carbohydrate is not. In order to reverse MD and obesity, and take control of our health, we must revert back to a diet based on regeneratively-raised ASF reminiscent to that of our pre-20th century ancestors. Nutrition comprised of as little as 1%E glycine is necessary for protection from sucrose-induced kidney damage and hypertension, which may be obtained from the connective tissue of ASF. The indicator amino acid oxidation (IAAO) is a new technique, validated by comparison with the “gold standard” nitrogen balance, established that determines protein requirements to be approximately 1 g/lb of bodyweight, which is more than double the RDA. PLH and ASF may be beneficial to consider with the idea of reducing the potential for these diseases across all populations. Furthermore, a diet containing 1%E of long-chain omega-3 fats from ASF may mitigate some of the detrimental effects of excess LA. Additionally, the adipogenic result of LA may be prevented with the intake of adequate DHA and EPA to minimize circulating AA-PL and return the ECB system to homeostasis. However, by reducing dietary LA to the evolutionary consistent 2%E and replacing it with saturated fat, that may not be necessary. By doing so, that may also allow OCFA’s and C18:0 to restore and regulate mitochondrial function, reduce VAT and mortality, reverse MD, and increase cancer survival and LBM. Linoleic acid has a half-life of 680 days, which means that half of it will still be stored in your cell membranes. Do you want to put something in your body that has so many downstream detrimental metabolic effects? Think about that the next time you open that bag or box of processed food or cook your meal in vegetable seed oils.

The carnivore diet is a recently popularized form of a ketogenic diet where all or most plant foods are removed so most of the nutrition originates from ASF. Clinical and historical data have found that all micronutrient requirements may be achieved on a plant-free diet, yet long-term consequences are unknown and further research is needed. While a carnivore diet may be extreme for some people, nutrition derived primarily from regeneratively-raised ASF with respect to calories, along with some whole plant foods is likely the most versatile and realistic dietary approach for society as a whole.

Bringing this home, I wanted to touch on our most recent pandemic. Although the pathophysiology of COVID-19 is multifactorial, IR is one of the primary determinants of MD. Restriction of dietary carbohydrates is an easy and safe intervention resulting in quick control of blood sugar. Therefore, the adoption of this one simple dietary strategy for people with underlying MS should be more widely promoted by government officials and policy makers worldwide to reduce the burden of pre-existing MD for people who contract COVID-19 now and indefinitely.

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