G. Charles Roland, MD
Mariya Kopynets, BS

THE SAN DIEGO KNEE CLINIC

Positive Correlation between Osteoarthritis, Obesity, Diabetes, and Joint Aging.

Strategies for Nutritious Dieting, Weight Loss, and Hormonal Balance.

We will be offering counseling on diet and exercise. If interested, please contact my office and schedule a medically supervised *Health and Orthopedic Fitness* assessment appointment which will include a spine and joint health assessment evaluation. This assessment will not be covered by health insurance.

G. Charles Roland, M.D.
Director of The San Diego Knee Clinic
Orthopedic, Arthroscopic and Reconstructive Surgery
Diplomate of the American Board of Orthopedic Surgeons
Fellow of the American Academy of Orthopedic Surgeons
San Diego Knee & Sports Medicine Fellowship

"I have written this paper so that my patients have a better understanding of the necessities of maintaining or attaining a healthier lifestyle to avoid the premature onset of osteoarthritis".

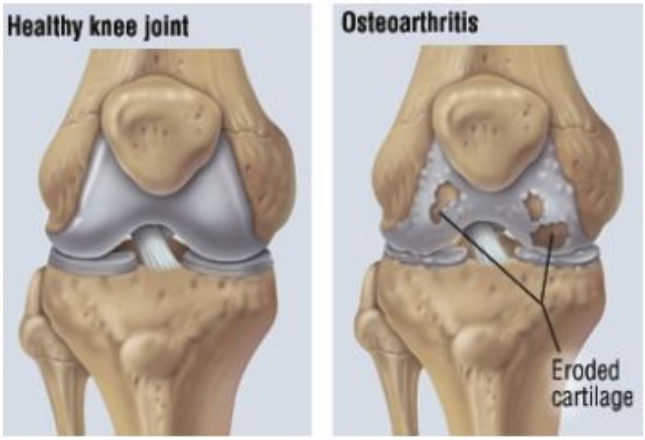
~ G.C. Roland

How does the diet fit into the degenerative process that we all will suffer from one day due to aging? This article discusses various weight loss strategies to reduce body weight including pertinent scientific facts. We know that increased weight beyond our lean body weight has deleterious effects on our joints both mechanically and metabolically. Premature Osteoarthritis is a direct byproduct.

Osteoarthritis (OA) and obesity evolve over a lifespan and are both chronic conditions. The Harvard Clinical and Translational Science Center describes osteoarthritis (OA) as a progressive degenerative joint disorder. The normal joint articular cartilage is a protective surface membrane found diffusely at the joint surfaces, which provides support and lubrication for healthy knee function.

Figure 1: Normal Knee and Osteoarthritis.

In OA kinematic and biomechanical changes affect the articular cartilage, causing subchondral bone remodeling (bone cysts, bone collapse, degeneration of menisci and ligaments, synovial and osteophytic bone enlargement and joint capsular hypertrophy. All of which are associated with OA pathogenesis[1].



Source: Harvard University Press

When the joint articular cartilage covering the bones of the knee wears away, it leaves bare bones in contact with each other causing mild to severe unremitting pain and swelling. The development of knee OA is linked to occupational variables (squatting, kneeling, etc), age, sex, history of prior knee injury, knee alignment (valgus and varus positioning), genetic heredity, and obesity [2]. A team of scientist in United Kingdom have concluded that obesity is a major risk factor for many disorders, OA included. They determined that modifying such risk factors may dramatically reduce the knee OA in general population, especially in the Western countries where obesity is widespread [3].

[1] Harvard University Press

[2] Felson, DT, et at. Osteoarthritis: new insights. Part 1: the disease and its risk factors. *Ann Intern Med* 2000; 133: 635-46.

[3] Muthuri, S.G., et al., What if we prevent obesity? Risk reduction in knee osteoarthritis estimated through a meta-analysis of observational studies. *Arthritis Care and Research.* 2011; 63: 982-990.

As defined in the Oxford Textbook of Medicine, **obesity** is an excess body fat that projects adverse effects on human health.[4] Obesity is linked to cardiovascular diseases, various forms of cancer, and frequently to type 2 diabetes. Obesity has been also linked to early structural changes including the presence of joint cartilage defects which stimulates the onset of osteoarthritis.[5] It is therefore important to note that besides the genetic and environmental factors contributing to OA onset and progression, the rate of change in obesity over time does drastically affect the risk and development of knee OA. The normalized body weight, muscle mass, muscle strength collectively decrease OA progression. In contrary to muscle mass, lower extremity fat mass increases the chance of joint-space width[6] cartilage defects,[7] and cartilage loss.[8] In obese patients the chronic weight load results in increased risk of OA, due to direct excessive impact on the joint biomechanics and tissue structures.[9] As a result, in the United States alone the number of total knee arthroplasties skyrocketed since 2004 to over 450,000. This number is predicted to increase up to 3.48 million in year 2030.[10] Most patients who undergo partial knee replacement are between 45 and 65 years old, while total knee replacement patients are between 50 to 80 years old**.** Many of these surgical procedures could be avoided by staying healthy and/or reversing major risk factors such as obesity prior to the onset of a debilitating disease or even cancer. I will provide the basic information and my opinions as to staying healthy, postponing the aging process as it affects the joints of the body, in particular the knee.

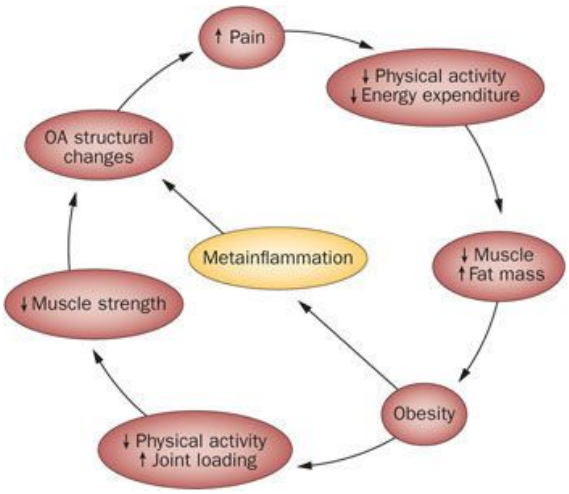


Figure 2 Obesity and OA: a vicious cycle
Sources: Nature Review Rheumatology

[4] Farooqi, I.S. Obesity. *Oxford Textbook of Medicine.* 2017. http://oxfordmedicine.com/view/10.1093/med/9780199204854.001.1/med-9780199204854-chapter-1105

[5] Wang, Y. *et al*. Body composition and knee cartilage properties in healthy, community-based adults. *Ann. Rheum. Dis.* **66**, 1244–1248 (2007).

[6] Sowers, M. F. *et al*. BMI vs body composition and radiographically defined osteoarthritis of the knee in women: a 4-year follow-up study. *Osteoarthritis Cartilage* **16**, 367–372 (2008).

[7] Berry, P. A. *et al*. The relationship between body composition and structural changes at the knee. *Rheumatology (Oxford)* **49**, 2362–2369 (2010).

[8] Cicuttini, F. *et al*. Association of cartilage defects with loss of knee cartilage in healthy, middle-age adults: a prospective study. *Arthritis Rheum.* **52**, 2033–2039 (2005).

[9] Sowers, M. R. & Karvonen-Gutierrez, C. A. The evolving role of obesity in knee osteoarthritis. *Curr. Opin. Rheumatol.* **22**, 533–537 (2010).

[10] Kurtz, S., et al. Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. *Journal of Bone Joint Surgery. American Volume.* 2007; 89: 780-5.

> Obesity can affect the pathogenesis of OA through biomechanical effects as well as via increased metainflammation (metabolic inflammation). Increased obesity is associated with higher levels of joint loading and reduced levels of physical activity, which in turn reduces muscle strength. Combined, these effects can result in the structural changes of OA. Structural disease results in pain, which presents a barrier to physical activity, further reducing energy expenditure and resulting in reduced muscle mass and increased fat mass. Thus, these factors may contribute to a vicious cycle of obesity and OA.[11]

Obesity is a major risk factor. The relationship between obesity and OA is not simple, encompassing a variety of influences that include mechanical loading, muscle function, metabolic and behavioural factors. In the obese patient, the abnormally increased amount of adipose tissue produces severe inflammation with increased inflammatory and metabolically active effects. Adipose tissue produces inflammatory cytokines such as **IL-6** and adipokines such as leptin. **Leptin** is found in synovial fluid, osteophytes, and chondrocytes(articular cartilage cells) of OA knee patients.[12] While IL-6 cytokine in women (n-908) is associated with increased risk of the radiographic OA (Livshits, 2009) and increased cartilage loss in another non-gender specific study (n=172).[13]

Other community based studies showed that elevation of leptin was inversely correlated with cartilage reduction.[14] Yet another study proved that proinflammatory cytokines also contribute to the perception of the pain acting as pain modulators.[15] Other factors related to OA onset and worsening are **ERα gene** mutation, as well as transforming growth factor and insulin like growth factor-1, which are crucial for proteoglycan (protein bonded to glycosaminoglycan groups) synthesis and articular cartilage formation.[16] These results showed that systemic factors produced by adipose tissue contribute to the early occurrence of OA and alter pain perception associated with obesity.

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[11] Wluka AE, Stuckey S, Snaddon J, Cicuttini FM. The determinants of change in tibial cartilage volume in osteoarthritic knees. Arthritis Rheum 2002;46:2065–72.

[12] Dumond, H. *et al.* Evidence for a key role of leptin in osteoarthritis. *Arthritis Rheum.* 48, 3118–3129 (2003).

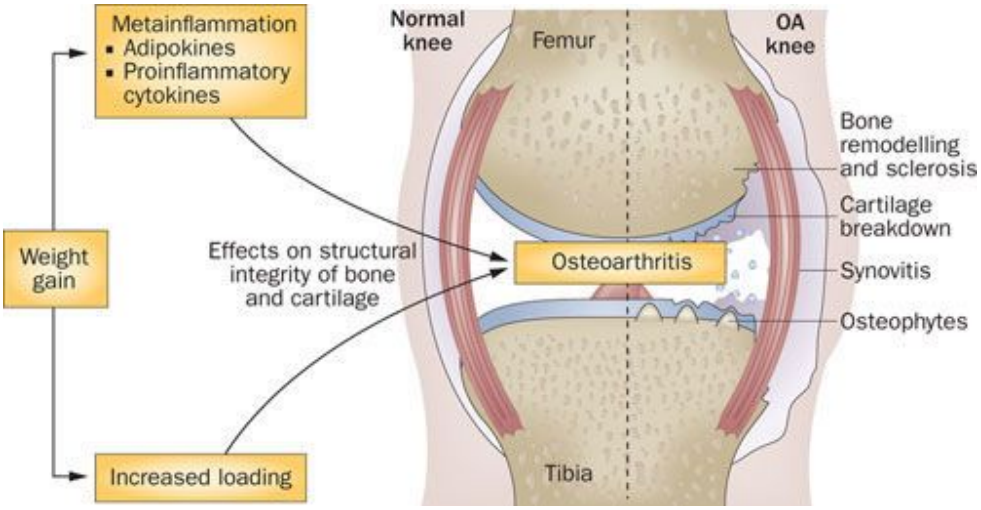
[13] Stannus, O. *et al.* Circulating levels of IL-6 and TNF-α are associated with knee radiographic osteoarthritis and knee cartilage loss in older adults. *Osteoarthritis Cartilage* 18, 1441–1448 (2010).

[14] Ding, C. *et al*. Association between leptin, body composition, sex and knee cartilage morphology in older adults: the Tasmanian older adult cohort (TASOAC) study. *Ann. Rheum. Dis.* **67**, 1256–1261 (2008).

[15] Sommer, C. & Kress, M. Recent findings on how proinflammatory cytokines cause pain: peripheral mechanisms in inflammatory and neuropathic hyperalgesia. *Neurosci. Lett*. 361, 184–187 (2004).

[16] Van der Kraan PM, Buma P, van Kuppevelt T, van den Berg WB. Interaction of chondrocytes, extracellular matrix and growth factors: relevance for articular cartilage tissue engineering. Osteoarthritis Cartilage 2002;10:631–7.

Figure 3 Mechanisms relating obesity to Osteoarthritis



Sources: Nature Review Rheumatology

"With increasing obesity, joint loading, as well as fat mass, become greater. Higher levels of adiposity are accompanied by inflammation, with production of adipokines and proinflammatory cytokines. The combined effect of adipocytokines and increased loading can facilitate the pathogenesis of OA, affecting bone, cartilage and synovial tissue"[17].

A team of Australian scientists performed a longitudinal study on 325 patients (males n=135, females n=190) and determined that with age the rate of tibial and patellar cartilage loss increases in various degrees for sexes, specifically females reported substantially higher tibial cartilage loss than males.[18] Moreover, a decreased bone density was detected which also declined with increased rate of change due to aging.[19]

Ding hypothesized that the higher levels of cartilage volume measured represented either 1) healthy subjects or 2) diseased cartilage which was swollen due increased water content and loss of aggrecan.[20] They have further confirmed with several MRI studies that age is directly correlated with lateral tibial and patellar cartilage loss in OA patients, yet not with medial tibial loss.[21] Furthermore, females had lower knee articular cartilage volume than males. **Ding and his colleagues found 45-58% more knee articular cartilage volume in over 50 year old males compared to**

[17] Wluka AE, Davis SR, Bailey M, Stuckey SL, Cicuttini FM. Users of oestrogen replacement therapy have more knee cartilage than non- users. Ann Rheum Dis 2001;60:332–6.

[18] Ding, C., et. al. A longitudinal study of the effect of sex and age on rate of change in knee cartilage volume in adults. *Rheumatology* 2007;46:273–279

[19] Jones G, Nguyen T, Sambrook P, Kelly PJ, Eisman JA. Progressive loss of bone in the femoral neck in elderly people: longitudinal findings from the Dubbo osteoporosis epidemiology study. Br Med J 1994;309:691–5.

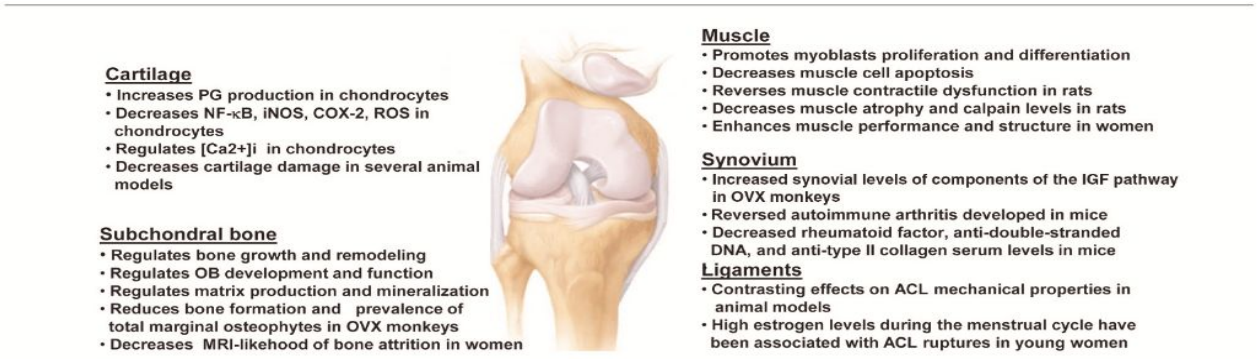
[20] Buckwalter JA. Cartilage. Part II: Degeneration and osteoarthrosis, repair, regeneration, and Transplantation. J Bone Joint Surg 1997;79-A:612–32.

[21] Wang, J., Wluka, E.I., Jones,G., Ding, C., Cicuttini, F.M., Use magnetic resonance imaging to assess articular cartilage. 2012 Apr; 4(2): 77–97.

females, and 30-37% more cartilage volume in males under 50 when compared to females of the same age range. Such differences in sexes are prevalent after age 50, implying that women have increased rate of cartilage loss in the post-menopausal period.[22] The reasons for such variables contributing to differences in OA onset and progression among sexes are growth factors, genes, and sex hormones.[23]

Human fetal cartilaginous tissue receptors such as estrogens, progesterone, testosterone[24], androgens, and 17 ß-estradiol stimulates human articular chondrocyte proliferation, collagen and proteoglycan synthesis in females, but not from males.[25] Also, the failure to maintain healthy estrogen production in women after the age 50 is associated with substantial loss of muscle mass, and as a result linked to significant muscular function deterioration.[26] In yet another study, diminished quadriceps muscle strength in the female population was noted to predict knee OA onset and degree of progression.[27] Lawrence and his team reported a nationwide population survey regarding radiographic generalized OA being three times more common in women aged 45 to 64 years compared to their male counterparts.[28]

Estrogen impact on target articular tissue



Estrogen actions on target articular tissues. ACL, anterior cruciate ligament; [Ca2+]i, intracellular calcium concentration; COX-2, cyclooxygenase-2; IGF, insulin-like growth factor; iNOS, inducible nitric oxide synthase; MRI, magnetic resonance imaging; OB, osteoblast; OVX, ovariectomized; PG, proteoglycan.

[22] Ding C, Cicuttini F, Scott F, Glisson M, Jones G. Sex differences in knee cartilage volume in adults: role of body and bone size, age and physical activity. Rheumatology 2003;42:1317–23.

[23] Ding, C., et. al. A longitudinal study of the effect of sex and age on rate of change in knee cartilage volume in adults. *Rheumatology* 2007;46:273–279.

[24] Ben-Hur H, Thole HH, Mashiah A et al. Estrogen, progesterone and testosterone receptors in human fetal cartilaginous tissue: immunohistochemical studies. Calcif Tissue Int 1997;60:520–6.

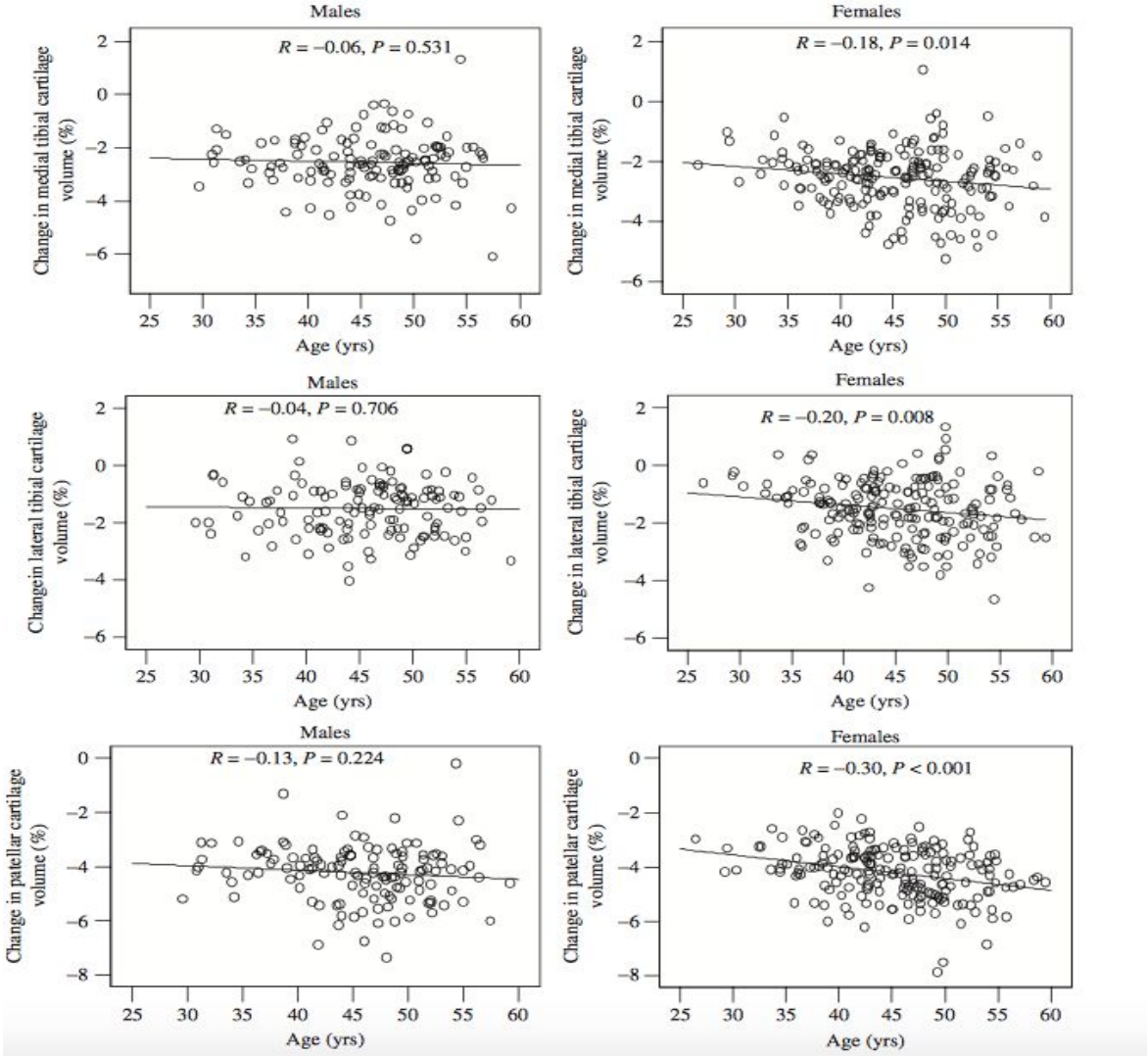
[25] Franchimont P, Bassleer C. Effects of hormones and local growth factors on articular chondrocyte metabolism. J Rheumatol 1991;27(Suppl):68–70.

[26] S. Sipilä. Body composition and muscle performance during menopause and hormone replacement therapy. Journal of Endocrinological Investigation. 2003, 26: 9: 893–901. https://link.springer.com/article/10.1007/BF03345241

[27] Slemenda C1, Heilman DK, Brandt KD, Katz BP, Mazzuca SA, Braunstein EM, Byrd D. Reduced quadriceps strength relative to body weight: a risk factor for knee osteoarthritis in women? Arthritis Rheum. 1998 Nov;41(11):1951-9.

[28] Lawrence RC, Helmick CG, Arnett FC, Deyo RA, Felson DT, Giannini EH, Heyse SP, Hirsch R, Hochberg MC, Hunder GG, Liang MH, Pillemer SR, Steen VD, Wolfe F: Estimates of the prevalence of arthritis and selected musculoskeletal disorders in the United States. *Arthritis Rheum* 1998, 41:778-799.

Figure 4. Knee cartilage loss, sex and age



Source: DING, et al. *RHEUMATOLOGY* 2007

"Association between age and rate of change in knee cartilage volume. Age was significantly associated with knee cartilage loss at all sites in females but not in males. Data points are presented after adjustment for Body Mass Index (BMI), offspring-control status, baseline cartilage volume, baseline bone size and/or radiographic OA (ROA) using residuals from the regression models and adding these to mean rate of change in cartilage volume or age".[29]

Nadkar analyzed the relationship between knee OA and menopause discovered that 64% of females suffered knee OA symptoms either pre-menopausal or within 5 years of natural menopause.[30] And a cross-sectional study revealed that using estrogen

[29] Ding, C., et. al. A longitudinal study of the effect of sex and age on rate of change in knee cartilage volume in adults. *Rheumatology* 2007;46:273–279.

[30] Nadkar MY, Samant RS, Vaidya SS, Borges NE: Relationship between osteoarthritis of knee and menopause. *J Assoc Phys India* 1999, 47:1161-1163.

replacement therapy postmenopausal women had more tibial cartilage volume as compared to the estrogen therapy non-users.[31]

Figure 5. Estrogen receptors currently on the market or in clinical trials

Partial list of selective estrogen receptor modulators and selective estrogen receptor ligands in clinical development

Pharmacologic group	Compound name	ER action (main target tissues)	Indications and stage of development
Chloroethylene	Clomiphene	ER antagonist (brain)	Ovulation induction*
Triphenylethylenes	Tamoxifen	ER antagonist (breast) ER agonist (bone, uterus and serum cholesterol)	Breast cancer therapy and prevention* Beneficial effects on BMD Beneficial cartilage effect. Animal models
	Toremifene	Similar to tamoxifen	Breast cancer therapy and prevention*
	Ospemifene	Similar to tamoxifen	Vaginal atrophy. Phase III
Benzothiophenes	Raloxifene	ER antagonist (breast) ER agonist (bone and serum cholesterol)	OP therapy and prevention* Breast cancer therapy and prevention*
	Arzoxifene	ER antagonist (breast and uterus) ER agonist (bone and serum cholesterol)	OP therapy and prevention. Phase III Breast and uterine cancer therapy. Phase II
Naphthalenes	Lasofoxifene	ER agonist (bone and serum cholesterol) High bioavailability	OP treatment. Phase III Vaginal atrophy. Phase III
Indoles	Pipendoxifene Bazedoxifene	ER antagonist (breast) ER agonist (bone and blood lipids)	Breast cancer therapy. Phase II OP treatment and prevention. Phase III
Hydroxy-chromanes	NNC 45-0781 NNC 45-0320 NNC 45-1506	Tissue-selective partial ER agonists	Postmenopausal OP prevention. Preclinical Beneficial cartilage effect. Animal models
Steroidals	HMR-3339	ER agonist (bone and serum cholesterol)	Decrease serum cholesterol. Phase II Postmenopausal OP treatment. Preclinical
	Fulvestrant	Steroid ER antagonist (breast)	Refractory breast cancer
Selective ER ligands	Pinaberel (ERB-041) WAY-169916 WAY-204688	ERβ-selective agonist NF-κB activity inhibition. No classical ER action Similar to WAY-169916	Chronic arthritis/endometriosis. Phase II Anti-inflammatory. Preclinical studies

*Products currently on the market. Levormeloxifen, a discontinued selective estrogen receptor modulator, also showed beneficial effects on cartilage in an animal model. BMD, bone mineral density; ER, estrogen receptor; OP, osteoporosis.

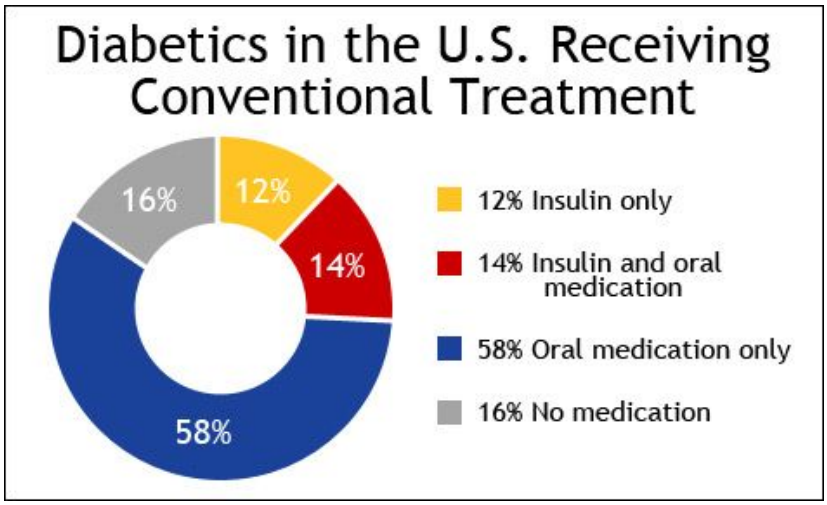
This literature review suggests the selective benefits of estrogen on joint tissues as well as reflects the potential of estrogen utility in OA treatment. Specifically, the suppressive effects of estrogen protects articular chondrocytes from oxygen-radical-induced damage.[32] Moreover, estradiol acts as a suppressor on proinflammatory proteins such as nitric oxide synthase, cyclooxygenase-2, NF-κB, and reactive oxygen species in articular chondrocytes.[33]

[31] Wluka AE, Davis SR, Bailey M, Stuckey SL, Cicuttini FM. Users of oestrogen replacement therapy have more knee cartilage than non- users. Ann Rheum Dis 2001;60:332–6.

[32] H. Claassen, M. Schünke, B. Kurz. Estradiol protects cultured articular chondrocytes from oxygen-radical-induced damage. Cell and Tissue Research. 2005, 319;3:439–445.

[33] Richette P1, Dumontier MF, Tahiri K, Widerak M, Torre A, Benallaoua M, Rannou F, Corvol MT, Savouret JF. Oestrogens inhibit interleukin 1beta-mediated nitric oxide synthase expression in articular chondrocytes through nuclear factor-kappa B impairment. Ann Rheum Dis. 2007 Mar;66(3):345-50. Epub 2006 Oct 26.

Diabetes Mellitus



The Standard American Diet (SAD) contributes to the epidemic of blood sugar disorders, making 84.5 million americans prediabetic, and 26 million Americans as Type 1 or Type 2 diabetics, at an annual cost of over $245 billion per year as reported by American Diabetes Association. Every year 1.5 million Americans are newly diagnosed with diabetes, and this number is rapidly increasing. Diabetes disrupts all aspects of human physiology and is the leading cause of neuropathy, blindness, kidney failure, and amputations. Diabetes increases the risk of cancer, cognitive degeneration, cardiovascular diseases, and many other diseases.

Type 2 Diabetes is caused by insulin resistance (promotes increased insulin production) or a lack of insulin production. Abnormalities of the blood sugar concentration are classified into reactive **hypoglycemia** -- low blood sugar, below 60, and **hyperglycemia** -- high blood sugar, above 100. High blood sugar is divided into either **type 1 or type 2 diabetes**. When the patient's immune system destroys the pancreas and the production of insulin stops leading to type 1 diabetes, the patient loses the ability to make insulin. The cause of type 2 diabetes results from the lack of physical activity, obesity, excessive carbohydrate intake promoting poor nutrition. Ingesting high-calorie, low-nutrient, processed foods. In type 2 Diabetes, often prior to the diabetes diagnosis, the patient has developed insulin resistance which is when the cells require an increased amount of insulin to push sugar into the cell that it does not need or want. *Inflammation and insulin resistance causes insulin receptor over-saturation and the sugar (glucose) is unable to get into the cell. The excess sugar is then converted into fat (**triglycerides)**--circulating fats*. High triglycerides content is always the first sign of insulin resistance with pre-diabetes. A patient may have normal blood sugar test results yet may be severely insulin resistant. The high demand for insulin eventually results in pancreatic failure, and can initially leads to excessive production of insulin by the pancreatic Beta cells(produce insulin)and eventually burn out of the pancreas leading to death of the Beta cells and diabetes.[34]

[34] American Diabetes Association position statement: Nutrition recommendations and interventions for Diabetes. Diabetes Care. 2008; 31(suppl): S61–S78.

How Hormones Affect Diabetes

A hormone is a chemical messenger that communicates, controls and regulates the activity between cells or organs. Hormones are essential for metabolism, growth, reproduction, digestion, and mood control.

At the root of virtually every illness are two hormones: insulin and cortisol. Created by beta cells in the pancreas, **insulin** drives sugar into virtually every cell in the body to be converted into energy. All foods, such as fats, proteins, and carbohydrates are eventually converted into glucose (sugar) to be utilized as fuel. Patients with insulin resistance are unable to lower and normalize the blood sugar level resulting in diabetes.

Another hormone created in the adrenal glands is **cortisol. Cortisol stimulates an** increase in serum blood sugar in response to stress by releasing **glycogen** (stored sugar) from the muscle tissue and liver. Cortisol also reduces the cell's insulin receptor sensitivity, which forces the pancreas to produce more insulin in attempt to lower blood sugar. This vicious cycle results in diabetes.

Diabetes and insulin resistance alters all aspects of human physiology. As defined by Richard K. Bernstein, MD "**genetic inheritance plus inflammation plus fat in the blood feeding the liver causes insulin resistance, which causes elevated serum insulin levels, which causes the fat cells to build even more abdominal fat, which raises triglycerides in the liver's blood supply and enhances inflammation, which causes insulin levels to increase because of increased resistance to insulin"**[35]

Inflammation and insulin resistance also causes insulin receptor over-saturation, resulting in sugar's inability to get into the cell. As a result, the excess sugar oxidizes and turns into *Advanced Glycation end Products (AGE)*. Our diet is then highly heat processed containing high levels of AGEs.

Dietary AGEs increase oxidant stress and inflammation, which are linked to the recent epidemics of diabetes and cardiovascular disease.[36] It is important to measure the AGEs via the Hemoglobin A1C marker. As defined by Mayo Clinic hemoglobin A1C also known as HbA1c test is used in medicine to diagnose type 1 and type 2 diabetes via a simple blood test. The HbA1c test measures the average blood sugar level for the previous 2-3 months. Specifically, the percentage of hemoglobin coated in sugar (glycated) on the red blood cell. Hemoglobin is a protein that carries oxygen and is contained in red blood cells. The HbA1c test reveals how well the patient is managing their blood sugar level. A higher A1C level shows that increased risk of diabetes complications.[37]

As a team of physicians and scientist in New York:

> "Consumers can be educated about low-AGE–generating cooking methods such as poaching, steaming, stewing, and boiling. For example, the high AGE content of broiled chicken (5,828 kU/100 g) and broiled beef (5,963 kU/100 g) can be significantly reduced (1,124 kU/100 g and 2,230 kU/100 g, respectively) when the same piece of meat is either boiled or stewed. The use of acidic marinades, such as lemon juice and vinegar, before cooking can also be encouraged to limit dAGE generation. These culinary techniques have long been featured in Mediterranean, Asian, and other cuisines throughout the world to create palatable, easily prepared dishes".[38]

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[35] R.K. Bernstein. Dr. Bernstein's Diabetes Solution: The Complete Guide to Achieving Normal Blood Sugars. 2011.. 4:43.

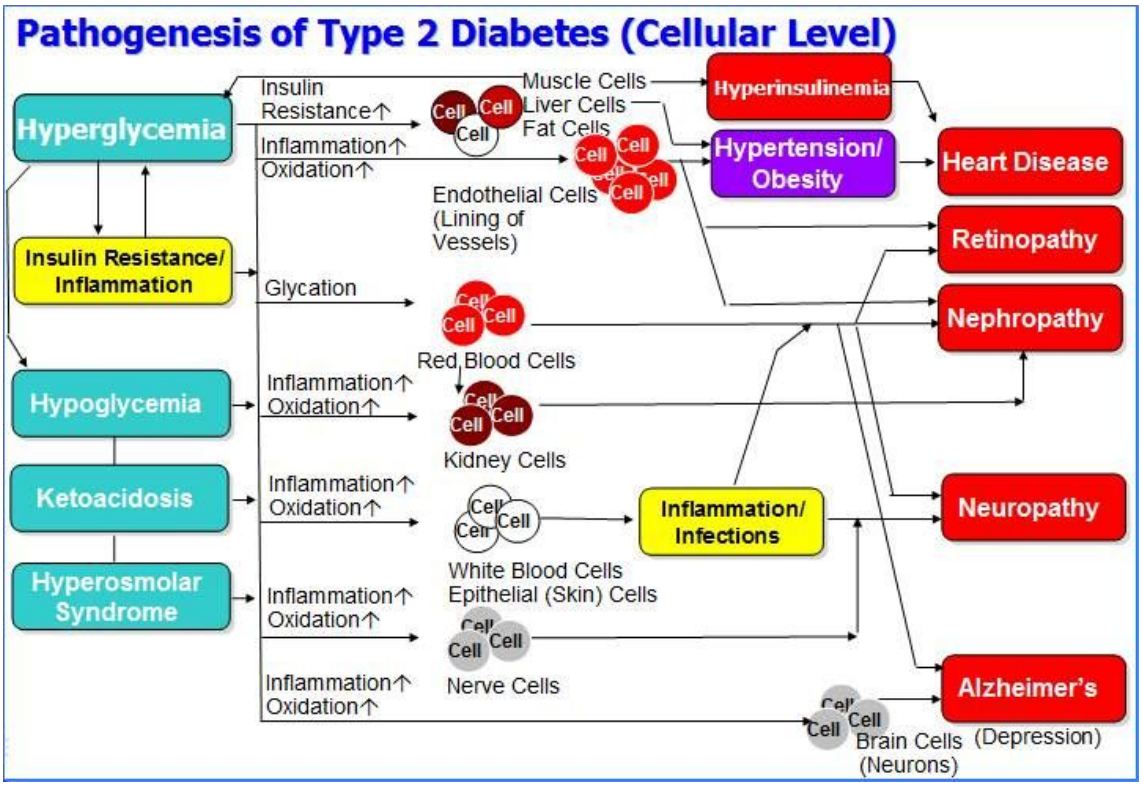
[36] Uribarri, J., et al. Advanced Glycation End Products in Foods and a Practical Guide to Their Reduction in the Diet. J Am Diet Assoc. 2010 June ; 110(6): 911–16.e12. doi:10.1016/j.jada.2010.03.018.

[37] Mayo Clinic. A1C test. http://www.mayoclinic.org/tests-procedures/a1c-test/home/ovc-20167930

[38] Uribarri, J., et al. Advanced Glycation End Products in Foods and a Practical Guide to Their Reduction in the Diet. J Am Diet Assoc. 2010 June ; 110(6): 911–16.e12. doi:10.1016/j.jada.2010.03.018.

The Hemoglobin A1C marker allows detecting how rapidly the patient's body is aging on the cellular level. Specifically, the **high levels of insulin joined with AGEs** results in inflammation and severe damage to the nerves, retinas, kidneys, and blood vessel tissues which can lead to blindness, kidney failure, neuropathy, and amputation in diabetics, and other physiological abnormalities.

Furthermore, the size of diabetic's brain shrinks twice as fast every year compared to a non-diabetic. Thus the reason why Type 2 diabetes is frequently referred to as a "silent killer" since the actual diagnosis is frequently made identifying visual changes, hypertension, and recurrent infections.[39]



Source: DeWayne McCulley book "Death to Diabetes", 2005.[40]

[39] R.K. Bernstein. Dr. Bernstein's Diabetes Solution: The Complete Guide to Achieving Normal Blood Sugars. 2011.. 4:44.

[40] DeWayne, McCulley. Pathogenesis of diabetes (Cellular level). *Death to Diabetes.* 2005. https://www.deathtodiabetes.com/author-bio.php

Sachin Patel at the Living Proof Institute described the following 8 human health categories regulated by insulin[41]

1. Insulin tells your liver to make more cholesterol. Cholesterol is the precursor to many of your hormones, including cortisol. Your body makes more cholesterol in response to the demands placed on it. This is a highly intelligent response to your environment and lifestyle, not an error. Your body never makes mistakes.

2. Insulin raises your blood pressure by increasing sodium retention. Many diabetics also have high blood pressure as a result of insulin issues.

3. Insulin keeps your liver from being able to detoxify properly. Your liver is like your body's oil filter. Your liver takes the trash and sludge out of your blood, but it can't do as good of a job when insulin and blood sugar are constantly elevated.

4. Insulin promotes inflammation, the very thing that causes insulin resistance. Inflammation promotes joint pain, cardiovascular disease, fluid retention, and weight gain to name a few. These diseases are often seen in diabetes patients.

5. High insulin levels in women cause them to make more testosterone. Symptoms include; polycystic ovarian syndrome or PCOS, hair thinning, and unwanted facial hair. Insulin can also affect the distribution of weight causing weight gain in the mid section.

6. Men end up with higher levels of estrogen when they have higher levels of insulin. This can contribute to breast enlargement and prostate issues with men, along with other things like erectile dysfunction and loss of motivation.

7. High levels of insulin are also directly related to higher risk for colon and breast cancer. Insulin promotes cell division and therefore also accelerates the aging process and cancer cell division. Cancer is more common in those with diabetes.

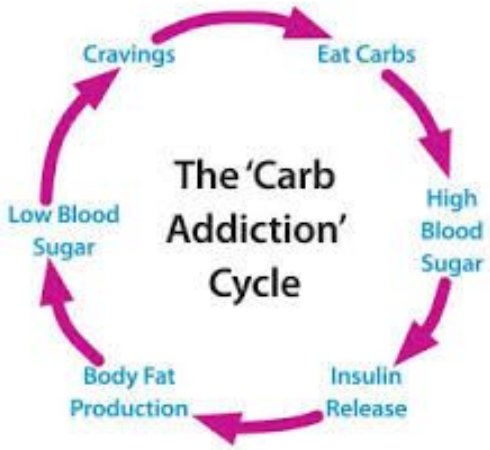
8. **High levels of insulin promotes weight-gain** because it is a fat storage hormone. When insulin can no longer drive sugar into cells to make energy, its job is then to store that sugar as fat for use at a later time.

[41] Sachin Patel. A Functional Medicine Approach to Diabetes. Living Proof Institute. https://thelivingproofinstitute.com/diabetes/

Richard K. Bernstein, MD

As described by Richard K. Bernstein, MD "the amount of triglycerides (fat storage) in your bloodstream at any given time will be determined by your heredity, your level of exercise, your blood sugar levels, your diet, your ratio of visceral (abdominal) fat to lean body mass (muscle), and especially your recent consumption of carbohydrates." He then explained that triglycerides are circulating in the bloodstream at all times, and that the elevated triglycerides' level is caused not by the dietary fat consumption but as a result of high daily carbohydrate consumption. He added that becoming overweight leads to insulin-resistance (requiring increased insulin production), causing even more overweight due to production and storage of fat tissue.

Approximately 80 percent of Type 2 diabetics are overweight and are affected by abdominal, visceral or truncal obesity.[42] Overweight is linked to heredity, yet most frequently it is caused by direct ratio of visceral and total body fat to muscle--lean body mass. The higher this ratio the more insulin-resistant the patient becomes.



"Whether or not an overweight individual is diabetic, his weight, intake of carbohydrates, and insulin resistance all tend to make him produce considerably more insulin than a slender person of similar age and height".[43]

Dr. Bernstein was diagnosed with Type 1 diabetes when quite young. As a result of self-treatment he became one of the early advocates of aggressive blood glucose control using blood glucose monitoring.[44] In his book he recommends to control diabetes with "The Law of Small Numbers", by keeping the blood glucose level as close to normal as possible by specifically consuming very small portions of carbohydrates at a time. Less carbohydrates have a more predictable effect on blood glucose levels.

In 2010 the American Diabetes Association (ADA) food pyramid recommendations suggested to consume at the minimum 84 grams of carbohydrate per meal, 3 meals/day. In the best case scenario, if the person consuming lower amounts of carbohydrates is a nonobese Type 1 diabetic with approximate weight 140

[42] R.K. Bernstein. Dr. Bernstein's Diabetes Solution: The Complete Guide to Achieving Normal Blood Sugars. 2011.4:43.
[43] R.K. Bernstein. Dr. Bernstein's Diabetes Solution: The Complete Guide to Achieving Normal Blood Sugars. 2011.4:50.
[44] R.K. Bernstein. Dr. Bernstein's Diabetes Solution: The Complete Guide to Achieving Normal Blood Sugars.

pounds who makes no insulin, each 1 gram of carbohydrate will raise the blood sugar level by about 5 mg/dl. Such high concentration of carbs, 84 grams for example, requires a high amount of insulin injected to keep the blood sugar level constant at the pre and post-meal period. In a Type 2 diabetic, obese patient, with some injected insulin each 1 gram of consumed carbs increases the blood sugar level by 3 mg/dl. The post meal blood sugar level could be anywhere between 141 mg/dl to 49 mg/dl.[45] Normal is 83. Bernstein concluded "big inputs cause big uncertainty". Bernstein also pointed out that food manufacturers when labeling the carbohydrate content on their products are allowed a 20% margin of error. Hence when consuming a minimum 84 grams of carbohydrate per meal 3 meals/day, each meal may be off by around 16.8 grams of carbs. And 84 grams for three meals equals 254 grams/day of carbs. If a gram of carbohydrate raises a person's blood glucose by 5 mg/dl, the predicted after-meal blood glucose level could be off by 84 mg/dl due to excess carbohydrates unplanned for by the individual.

The final recommendation by Bernstein for meal planning is "keeping the protein and carbohydrate content of each meal consistent from one day to the next"[46], eliminating from the diet all "simple sugar", fast acting carbohydrates such as sweets, milk, low-fat yogurt, fruits and juices, starchy and sweet vegetables, grains, pasta, and processed foods. He advices to consume no more than 6 grams of carbohydrate at breakfast, and 12 grams of carbohydrate for lunch and the same amount for dinner. He recommends ingesting only slow-acting carbohydrate foods such as salad greens and non sweet vegetables. He advises people to get the remainder of their calories from foods that do not significantly affect blood glucose level, such as meat, chicken, fish, seafood, eggs, tofu, hard cheeses, whole milk yogurt, cream and certain types of high-fiber crackers.

In general, it is easier to lose weight on a low carbohydrate diet as the insulin response is muted allowing the patient to drop their blood sugars and reduce the insulin response. It is very important to follow a calorie reduced diet as well till one reaches a normal body weight. How do you know what your total calorie requirement is per day? It is based on your body type, height, and lean muscle mass. An average person should ingest about 1200 to 1800 calories per day. A person of my size, 74 inches in height, requires around 1800 calories per day without doing excessive exercise. The are several testing methods to determine your caloric needs. This will be a topic of a different paper.

[45] R.K. Bernstein. Dr. Bernstein's Diabetes Solution: The Complete Guide to Achieving Normal Blood Sugars. 2011; 11:109.
[46] R.K. Bernstein. Dr. Bernstein's Diabetes Solution: The Complete Guide to Achieving Normal Blood Sugars. 2011; 11:147.

Fasting and Weight Loss-Bair

An alternative approach to the weight loss paradigm as recommended by Stephanie Bair from Stanford university is the intermittent energy restriction (IER) alternative.[47] IER refers to restrictive daily calorie intake, which could be performed in a number of ways.

1. A 24 to 36 hours fasting period once a week;
2. confining meal intake to a 6-8 hour daily time frame;
3. or severely restricting calorie intake to 400-500 total calories per day.

If there are no medical conditions cautioned by your physician to avoid fasting, you may start at any time. There are many forms of fasting and dieting, and due to our individual differences it may take some experimentation to explore what fits your body best. The 500-600 calorie diet is no picnic. Be smart and pick your favourite food day by day, one at a time. Gradually, the initial feeling of deprivation will fade and lessen.

Weight-loss Strategy-Mosley

Dr. Michael Mosley strategized on managing appetite temptations and strengthening one's willpower in making prudent and healthy snacking choices. Dr. Mosley described that on average we make 227 food-related choices daily[48], and in order to control our snacking habits we must identify in advance our temptations. Specifically, he advised:

I. Know your triggers: as a rational being you are in power to select or ignore each food craving experience. This takes grit and willpower. The appreciation of this power will promote deliberate practice, which ultimately allows overcoming the cognitive bias of cravings. For instance, instead of midnight snacking, choose to drink a cup of green tea instead of late-night fridge raid. Take a shower/bath. If you are prone to ordering dessert at restaurants choose to have your lunch at the office or nearby public park.

II. Know temptations are fast-coming and fleeting: distract your mind for 2-5 minutes. Meditate with deep breath, drink a cup of water or green tea, call a friend for a minute, walk and talk to your co-worker.

III. Exercise the "Proximity Principle" and store temptations distantly: the *International Journal of Obesity* published a case study showing that candies stored conveniently close to hand were consumed at a significantly higher rate compared to

[47] S. Bair. Intermittent Fasting: Try This at Home for Brain Health. Law and Bioscience Blog. https://law.stanford.edu/2015/01/09/lawandbiosciences-2015-01-09-intermittent-fasting-try-this-at-home-for-brain-health/
[48] M. Mosley, M. Spencer. The Fast Diet. 2013.

those not as visible and easily accessible. A good strategy is to replace unhealthy cookies with fresh/dried/frozen fruits to consume as snacks.[49]

IV. Remember that your goal outweighs your temptation: it is important to recall what made you decided to start losing weight: longer life, healthy body, better cognitive performance, smaller medical bills. Take a photo of yourself and tape it on your fridge door to serve as reminder.

V. Exercise willpower: Kelly McGonical from Stanford University wrote an entire book *The Willpower Instinct: How Self-Control Works, Why It Matters, and What You Can Do to Get More of It,* suggesting that willpower should not be perceived as integrity but instead as a muscle; the more the "willpower" muscle is exercised the stronger it becomes.Thus perseverance in willing to overcome temptations will promote ease in losing weight.

In all, healthy dieting will promote your longevity and prolong healthy long life.

Dr. Michael suggested that once the target weight is reached the Maintenance model should be introduced to support the healthy Body Mass Index (BMI). Weight loss will promote BMI and body fat measurements to drop, the cholesterol count, IGF-1, and blood glucose level to improve. Factors that will promote longevity and health.

$$\text{1. Metric: } BMI = \frac{\text{weight (kg)}}{(\text{height (m)})^2}$$

$$\text{2. English: } BMI = \frac{\text{weight (lb)}}{(\text{height (in)})^2} \times 703$$

Figure: BMI Formula

There is overwhelming scientific evidence that a low carb Mediterranean-style diet — one rich in vegetables, fish, olive oil, nuts and the occasional glass of wine or a bite of dark chocolate — is better for weight loss, blood sugar control and improving cholesterol than going on a low fat diet. Pasta is not included.

[49] Wansink, B., Sobal, J. *Mindless Eating: The 200 Daily Food decisions we Overlook*, Environment and Behavior. 2007. Print. Wansink, B., Painter, J.E., Lee, Y.K. *The Office Candi Dish: Proximity's Influence on Established and Actual Consumption,* International Journal of Obesity, 2006. Print.

Weight Loss-Robert Atkins, MD

THIS DIET IS NOT NECESSARILY ADDRESSING DIABETES BUT MOSTLY PROVIDES A PROGRAM TO LOSE WEIGHT.

To start the Atkins low carb journey there are four phases established by the Low Carb diet pioneer Robert Atkins, MD[50]

- **Phase 1 - Induction**

Kickstart your weight loss and get started on your low carb transformation.

- **Phase 2 - Ongoing Weight Loss**

Enjoy your low carb confidence and find your carb tolerance.

- **Phase 3 - Pre-maintenance**

Continue adding good carbs until you find your level that allows maintaining the lost weight.

- **Phase 4 - Maintenance**

Establish a long-term way of being healthy for good.

Source: R. C. Atkins, MD "Dr. Atkins' New Diet Revolution"

Determine for yourself which phase is designed for your nutritional goals:

- **Phase 1 - Induction**

  Phase 1 is about transforming your body into a fat burning machine and kickstarting your weight loss. By limiting the amount of carbs you eat to around 20g a day, your body will switch its main fuel source from carbs to fat. Every phase of the New Atkins plan is based on proven scientific principles and is a completely safe, natural way to lose weight.

  Finding the Phase for you

  Phase 1 isn't for everyone, of course. If you don't have that much weight to lose or if you are vegetarian for example, you'll start in Phase 2 instead.

  - ➢ As a rough guide, start at Phase 1 if:
  - ➢ Your goal is to lose 14lbs (7kg) or more
  - ➢ You're inactive or have a slow metabolism
  - ➢ You've regained the weight you once lost
  - ➢ You want to lose a little bit of weight, but quickly

[50] Eric C. Westman, Jeff S. Volek, and Stephen D. Phinney. The New Atkins for a New You. 2010.

Guidelines

To start your low carb diet, there are a few rules you need to stick to.

- ➢ Eat 3 regular sized meals a day or 4-5 smaller meals
- ➢ Don't skip meals or go for longer than 6 hours during the day without eating
- ➢ Eat at least 115-175 grams of protein-rich food for every meal (up to 225g for taller men)
- ➢ Eat 20g of carbs per day
- ➢ 12-15g of your carb total should come from cooked vegetables and salad
- ➢ You can also take a daily iron-free multivitamin/multimineral tablet and an omega-3 fatty acid supplement to make sure you are getting all the nutrients you need
- ➢ Drink 8 glasses of water (or other acceptable drinks) per day

The induction phase is about helping you distinguish hunger from habit, and changing the amount what you eat to suit your appetite as it decreases.

When you're hungry, eat until you're satisfied but not overly full. If you're unsure, wait ten minutes and have a glass of water to see if you're still hungry. If you don't have a big appetite at mealtimes, instead of skipping your meal, have a small low carb snack.

- **Phase 2 - Ongoing Weight Loss**

Now you've got to grips with your new low carb lifestyle, you can start to enjoy a greater variety of foods. In this phase you will find your carb tolerance – that's the level of carbs you can eat daily while still losing weight at a steady pace.

Phase 2

If you don't have that much weight to lose, want greater food variety or if you are vegetarian, you can skip Phase 1 and start in Phase 2. Our BMI counter or our nutritionists can help you decide what Phase is best for you.

As a rough guide, starting in Phase 2 is right for you if:

- ➢ Your goal is to lose less than 14 lbs (7kg)
- ➢ You're happy to lose weight a little more slowly
- ➢ You have more weight to lose but want to enjoy more food variety

➢ You're vegetarian

Guidelines

In Phase 2, you will increase your carb intake little by little to find your carb tolerance. You can now add nuts, seeds, berries and certain cheeses to your menu, as well as Atkins food products such as muesli, bread mix and penne pasta.

By increasing your carbs gradually, you'll find out exactly how many carbs you can eat while still working towards your goal weight. It'll form the foundation of your low carb lifestyle in the long term.
Remember, weight loss in this phase usually happens at a steadier pace than in Phase 1. Be patient, if you stick to a few rules, you will get to your goal.

- ➢ Vegetarians start at 30g of carbs per day
- ➢ You can add an extra 5g of carbs per week (up to 40g) to find your carb tolerance
- ➢ You can now add nuts, seeds, berries and certain cheeses to your diet
- ➢ You can now enjoy Atkins food products, such as muesli, bread mix and penne pasta
- ➢ Monitor your daily carb intake – which you can do using our carb counter
- ➢ Eat plenty of natural fats
- ➢ Continue to take your multivitamin, multimineral and omega-3 supplements
- ➢ Consume eight glasses of water (or other acceptable fluids) per day

- **Phase 3 - Pre-maintenance**

With your goal weight in sight, Phase 3 is all about helping you establish a long-term way of eating so you can stay happy and healthy for good.

Getting the balance right

As you get ready to hit your target, slow and steady weight loss is the name of the game. Phase 3 is also about building up your carb tolerance, so hit by the time you're ready to move on to Phase 4, you know what works for you in the long-term.
We're all different, so what works for one might not work for another. If you have any questions or find yourself struggling, you can turn to members of our Atkins community or our nutritionists for extra support.

Listen to your body

During Phase 3, you will increase your carb intake by 10g per week. This is so you can find your carb balance – the ideal level that will allow you to reach your goal weight and stay there. Everyone's different, so it is just trial and error. Take it at your own pace and listen to your body.

By the time you reach your goal weight and have kept it there for a month, you should have a pretty good idea of what amount and type of carbs your body can handle, and what it can't.

Fine-tuning your carbs

If your cravings come back or your weight loss stalls, drop your carb intake by 10g for a week, then introduce an extra 5g until you find your level. In this final 'fine-tuning' stage of your plan, you'll discover the balance between what you can eat and maintaining your ideal weight.

Remember, weight loss will be slower as you work find your carb balance. Be patient, if you stick to a few rules, you will find the carb limit that will help you stay at the weight your happy weight. You can add an extra 10g of carbs per week (up to 100g) to find your carb balance.

You can now add pulses, starchy veg, more fruits and grains to your diet
Monitor your daily carb intake – which you can do using our carb counter
Consume eight glasses of water (or other acceptable fluids) per day.

- **Phase 4 - Maintenance**

You've done it! You've reached your goal weight and you've stayed there. It a wonderful achievement, and something that should be really proud of. Phase 4 is all about helping you enjoy your healthier, low carb life in the future – and keeping you at the weight you're happy with.

Keeping your Atkins edge

You know the ins and outs of low carb living off by heart by now, so you won't be surprised to hear that the work doesn't stop just because you've hit your goal. If you keep the carb balance that you've refined over the last weeks and months, there's nothing to stop you staying at your goal weight indefinitely.

If you do have a period where things slip and you gain weight or your cravings come back, don't panic. You can get back your 'Atkins edge' by simply dropping your carb in take by 10 to 20 grams to regain control.

Low carb for life

> Going forward, you can continue to eat the same variety of foods you enjoyed in Phase 3 with one slight adjustment – your fate intake may go down as your carb intake increases.
>
> Being active is important to for a balanced, healthy lifestyle. If you're not already exercising, now is the perfect time to get moving. As well as reducing your risk of a number of illnesses, it'll help you keep the weight off.
>
> ***~ Atkins Nutritionals Inc., United Kingdom***

Atkin felt that the non-diabetics (or diabetic patients who normalized their blood sugar level), need to consume less than 100 net grams of carbs per day[51]. He also created the Atkins Lifestyle Food Guide Pyramid where consumption of high fat and protein, fiber-rich leafy vegetables and healthy oils are prioritised over carbohydrates. Atkins also advised the low-carb diet to help with weight loss for obese patients.

Ketosis and Ketogenic diet

The name ketosis originates from "ketone" molecules. Ketones are a byproduct created when the human body breaks down fat for energy when carbohydrate intake is low. Thus ketones are produced by the liver as an alternative fuel to be used by the body, when the blood sugar content is in short supply. When on ketogenic diet, the entire body runs almost entirely on fat. As a result, the insulin level lowers dramatically, and the maximum fat burning process begins. For the fastest way to attain the state of ketosIs (when the body produces ketones), it is recommended to fast and check the urine for ketosis confirmation using a keto stick that can be bought at your local pharmacy. However, fasting could be challenging at times for patients with A weakened immune system. As an alternative, A ketogenic diet can be could consumed indefinitely and also results in permanent ketosis with weight loss.

The father of modern medicine Hippocrates advised "Let your food be your medicine, and your medicine be your food".[52] The ketogenic diet is characterized as low carbohydrate, high fat, and moderate to low protein content. Although carbs are excluded from the diet as a source of fuel to the brain and skeletal muscles. Ketone bodies with β-hydroxybutyrate and acetoacetate contained in a high fat diet are the alternative energy sources for the brain and the body.

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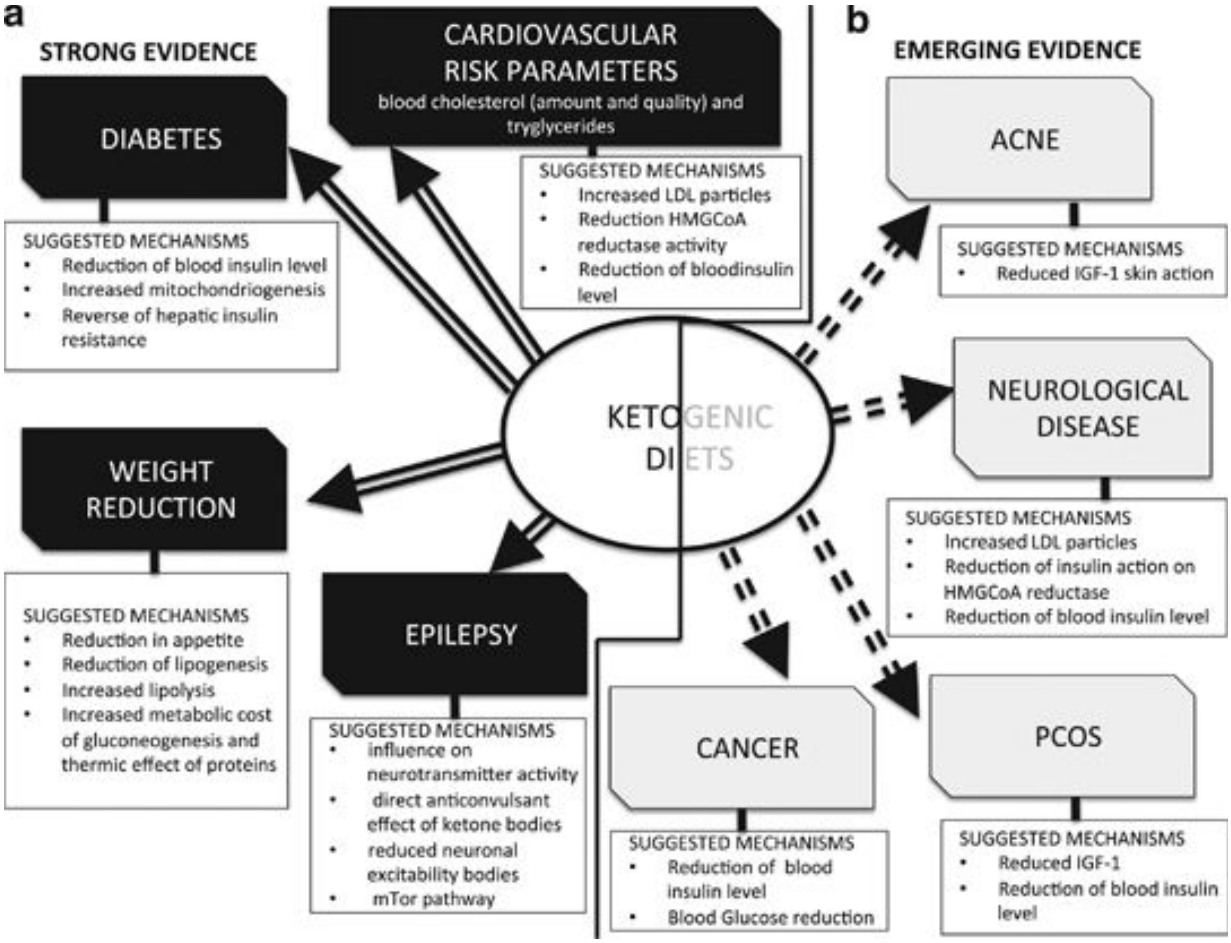
[51] Atkins: Low Carb Diet Program and Weight Loss Plan.

[52] Singh, M. (2014). Mood, food, and obesity. *Frontiers in Psychology: Eating Behavior.* 5(925): 111,



Source: Beyond weight loss: a review of the therapeutic uses of very-low-carbohydrate (ketogenic) diets.[53]

Evolutionarily, our bodies evolved to store fat so that we could survive and function for a prolonged period without food. By providing our body and brain the lasting constant supply of energy, we ensure more efficient mental and physical endurance. As mentioned before, the by-products of fat burning metabolism are ketone bodies – acetoacetate, β-hydroxybutyrate and acetone. When consuming a low carbohydrate diet our bodies uses fats as fuel and produces large number of acetyl-CoA, which exceed the capacity of the Krebs cycle, leading to the making of these three ketone bodies within liver mitochondria. The Kreb cycle -takes place in mitochondria, consuming oxygen, producing carbon dioxide and water as waste products, and converting ADP to energy-rich ATP (**Adenosine triphosphate**) - the sequence of reactions by which most living cells generate energy during the process of aerobic respiration.

[53] A Paoli, A Rubini, J S Volek and K A Grimaldi. Beyond weight loss: a review of the therapeutic uses of very-low-carbohydrate (ketogenic) diets. European Journal of Clinical Nutrition (2013) 67, 789–796

As a result the concentration of ketones in the blood is elevated and the brain readily uses the ketones for energy. Ketone bodies cross the blood brain barrier very readily. When energy is used in the form of ketones, they release acetyl-CoA which then migrate to the Krebs cycle again to continue producing more energy. Ketones also can be readily used by the heart.

The metabolic state of ketosis has many benefits, in addition ketotic state reduces hunger, facilitating effortless weight loss. It is important to note that since ketosIs requires a very limited amount of carbohydrate consumption, it can effectively reverse type 2 diabetes. Ketosis has also been used for epilepsy treatment, showing that ketones production reduces the amount of seizures in patients. Recent research at university of Maryland showed that 32% epileptic patients treated with a ketogenic diet and 29% of patients on the Atkins diet had at least 50% reduction in seizures. Moreover, 90% reduction of frequency of epileptic seizures was reported in 9% patient following ketogenic diet and 5% patients who followed the modified Atkins diet.

It was noted that "the anticonvulsant effect occurs quickly with both diets, within days to weeks." Surprisingly to the researchers, the most frequent side-effect reported was weight-loss, which as they noted was "maybe advantageous inpatients with obesity".[54]

Ketogenic Diet and Sports Biomechanics

During endurance training, such as the triathlon, marathon, and cross country cycling, fat oxidation is the most significant metabolic adaptation, since it provides cognitive and muscular strength for athletes. During aerobic system training for example, the total allowance of fat-based energy source increases exponentially. Now the muscle of athletes uses larger mitochondrial density that helps them to oxidize more fat as fuel source, which enables a longer exercise time. Postponing glycogen exhaustion and fatigue during and after training. Furthermore, athletes during exercise deliver more oxygen and blood flow to the muscles as a result of arteriovenous oxygen variance and increased cardiac functions.[55] These processes promote fat oxidation, usage as a source of fuel for the body by breaking down fat at higher rate, ergo differentiating "ketone fueled" athletes from carb-eaters. As a result, athletes who obtain energy from ketones perform with more efficiency for a longer time period, while athletes who are carbohydrate consumers whose glucose is metabolized at a higher

[54] P. Klein, C. I. Tyrlikova, G. C. Mathews, Dietary treatment in adults with refractory epilepsy. American Academy of Neurology. https://www.authoritydiet.com/papers/KETO-SEIZURESS-1.pdf

[55] Zajac, A., Poprzecki, S., Maszczyk, A., Czuba, M., Michalczyk, M., and Zydek, G. The Effects of a Ketogenic Diet on Exercise Metabolism and Physical Performance in Off Road Cyclists. *Nutrients.* 2014.6: 24932508.

speed, are left with no energy fuel to continue their exercise. They burn out within a much shorter timespan due to lack of adequate fuel from food.

Autophagy (cell death) is a intracellular degradation system that delivers cytoplasmic constituents to the lysosomes and is enhanced by ketosis and is very important because it can target virus and bacteria growing inside cells. Metabolic ubnormalities within the cell affect virus and bacteria that result in acute mitochondrial damage.[56]

Mitochondria, as defined by Michael W. Davidson in the *Molecular Expressions,* "are rod-shaped organelles that can be considered the power generators of the cell, converting oxygen and nutrients into adenosine triphosphate (**ATP**). ATP is the chemical energy "currency" of the cell that powers the cell's metabolic activities. This process is called **aerobic respiration** and is the reason animals breathe oxygen. Without mitochondria (singular, mitochondrion), higher animals would likely not exist because their cells would only be able to obtain energy from anaerobic respiration (in the absence of oxygen), a process much less efficient than aerobic respiration. In fact, mitochondria enable cells to produce 15 times more ATP than they could otherwise, and complex animals, like humans, need large amounts of energy in order to survive".[57]

Producing ketones is our best chance to preserve our mitochondria form damage. Along with increasing GABA - the body's natural valium, the increased production of acetyl-CoA produced by the ketone bodies encourages the Krebs cycle, to increase mitochondrial NADH (reduced nicotinamide adenine nucleotide) which is used by the body in over 450 important biochemical reactions. This includes cell signalling and continuing assistance of the body's ongoing DNA repair. Ketones also contribute to the production of anti-oxidants which protect us from toxic elements, such as glutathione. Last but not least, ketone body beta-hydroxybutyrate produces more ATP for energy, since it is more energy rich than pyruvate.[58] This process allows for production of more energy.

Our body stores only a two-day supply of glucose in the form of glycogen in the liver, so after **two days** of consuming no more than 20 grams of carbohydrates, **most people go into lipolysis/ketosis, using fat for energy**.[59]

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[56] Prasenjit Manna, PhD and Sushil K. Jain, PhD. Metabolic Syndrome and Related Disorders. November 2015, 13(10): 423-444.https://doi.org/10.1089/met.2015.0095

[57] Davidson, M.W. *Mitochondria.* Molecular Expressions. Cell Biology and Microscopy Structure and Function of Cells and Viruses. 2015. https://micro.magnet.fsu.edu/cells/mitochondria/mitochondria.html

[58] G. Segura, MD. The Ketogenic Diet – An Overview. http://health-matrix.net/2013/08/09/the-ketogenic-diet-an-overview/

[59] Everything You Wanted To Know About Ketosis And Ketone Testing Strips. Netrition. The Internet's Premier Nutrition Superstore. https://www.netrition.com/lowcarb_newbies_ketosis.html

To measure whether the person is in ketosis, technology is applied to determine the level of ketone bodies found in the body:

1. **Acetoacetate (AcAc)** - primary ketone body found in the urine.
2. **Beta-hydroxybutyrate (BHB)** - the primary ketone body in the blood.
3. **Acetone** - the primary ketone body in the breath.

Source: *Clarity: Your Definitive Guide to the Benefits of a Low-Carb, High-Fat Diet.*[60]

Ketostix purchased at the drug store can measure your ketones and state of ketosis in the urine and relatively inexpensive.

MENU: Seven Days of Low Carb Living[61]

Here are seven days of menus one might follow on a maintenance diet providing less than 50 grams per day of total carbohydrates. The portions indicated provide between 2400 -2800 kcal per day, suitable for a normal weight, active male 5'9" tall. The division between fat, protein, and carbohydrates are listed at the bottom of each day's menu in both kilocalories and as percent of total energy. These are not provided as a diet prescription for any one per se, but as an illustration of the amount and variety of foods one can eat on a well formulated low carbohydrate diet. Note also that this variety is achieved while keeping the total daily carbohydrate between 30 and 50 grams. Thus someone with less carbohydrate intolerance (e.g., able to tolerate 80 grams per day) will have even an even greater variety of food choices.

❑ Day 1 in the Low Carb Life

Breakfast
berry smoothie (low carb, high fat)

Lunch
2 cups mixed greens
6 oz water pack tuna
10 black olives
½ cup blue cheese dressing (yogurt, olive oil)

Snacks
2 oz mixed nuts, broth
2 oz soft cheese with6 oz celery

[60] J. Moore, E. Westman, MD. *Clarity: Your Definitive Guide to the Benefits of a Low-Carb, High-Fat Diet.* 2014.

[61] Phinney, Stephen & Volek, Jeff. The Joy of Cooking (and eating) fat. *Art and Science of Low Carbohydrate Living. Chapter 17, pp. 23-36.*

Dinner
8 oz tomato bisque
8 oz steak
4 oz buttered green beans
4 oz sauteed mushrooms
4 oz maple walnut ice cream (made w/ sucralose/xylitol)

Total: 2100 kcal fat, 600 protein, 150 carbs (74% fat, 5% carb,21% protein)

- ❑ **Day 2**

Breakfast
2 eggs
2 slices bacon
½cup sauteed mushrooms

Lunch
1 cup beef broth
6 oz cold roast pork lettuce wedge
2 oz honey basil dressing

Snacks
2 oz mixed nuts, broth
2 oz cheddar cheese

Dinner
6 oz roast chicken with fennel kale sauteed with bacon,
garlic, and olive oil
4 oz berries with cream

Total: 1800 kcal fat, 520 protein, 130 carbs (73% fat, 5% carb,22% protein)

- ❑ **Day 3**

Breakfast
black coffee
cauliflower corned-beef hash with peppers and onions (1 tbs olive oil)

Lunch
Chicken Caesar salad(takeout, 4 oz chicken)
½ packet commercial Caesar dressing (made with soybean oil)
1 tablespoon olive oil
unsweetened iced tea

Snacks
2 oz mixed nuts, broth

2 oz soft cheese with
6 oz celery

Dinner
8 oz sorrel soup
8 oz baby back pork ribs lettuce wedge (8 oz)
2 oz yogurt/blue cheese dressing
1 oz bacon bits
1 oz blue cheese crumbles
2 oz chopped tomatoes
2 oz chopped cucumber

Total: 1880 kcal fat, 490 protein, 120 carbs (76% fat, 5% carb,19% protein)

- ❑ **Day 4**

Breakfast
2-egg omelet (1 oz each bacon, mushrooms, cheese, tomato)
black coffee

Lunch
2 cups Cobb salad (takeout)
1 tablespoon olive oil
Unsweetened iced tea

Snacks
2 oz mixed nuts, broth
10 black olives stuffed with ripe brie cheese

Dinner
8 oz French onion soup (with 2 oz guerre cheese and 2 oz onion)
Sole stuffed with creamed spinach in cheese sauce
Blueberry cheese cake

Total: 1600 kcal fat, 440 protein, 120 carbs (74 % fat, 6% carb, 20% protein)

- ❑ **Day 5**

Breakfast
black coffee
3 oz smoked salmon
1 oz creamed cheese
1 tbsp capers
6 lettuce leaf wrappers

Lunch
2 cups mixed greens
6 oz water pack tuna
10 black olives
½ cup blue cheese dressing (yogurt, olive oil)

Snacks
2 oz mixed nuts, broth
2 oz soft cheese with
6 oz celery

Dinner
12 oz low carb sausage chili
8 oz grilled asparagus with herb butter
4 oz cocoa pecan ice cream

Total: 1810 kcal fat, 530 protein, 200 carbs (71 % fat, 8% carb, 21% protein)

- ❑ **Day 6**

Breakfast
black coffee
4 oz ham slices wrapped around 4 oz cold grille buttered asparagus

Lunch
Double bacon cheeseburger (no bun)
Unsweetened iced tea

Snacks
2 oz mixed nuts, broth
4 oz diced cucumber, 2 oz diced tomato
2 oz yogurt blue cheese dressing

Dinner
8 oz bacon wrapped steak
4 oz french-fried green beans
4 oz sauteed mushrooms
4 oz maple walnut ice cream (made w/ sucralose/xylitol)

Total: 1755 kcal fat, 564 protein, 132 carbs (72% fat, 5% carb,23% protein

❑ **Day 7**

Breakfast
mocca freeze smoothie

Lunch
2 cups mixed greens
6 oz water pack tuna
10 black olives
½ cup blue cheese dressing (yogurt, olive oil)

Snacks
2 oz mixed nuts, broth
2 oz soft cheese with
6 oz celery

Dinner
Coq au vin (stewed chicken)
4 oz tomato
4 oz sauteed mushrooms
2 oz onion lettuce wedge with honey basil dressing

Total: 1727 kcal fat, 520 protein, 224 carbs (70% fat, 9 % carb, 21% protein)

Additionally, consider this menu for a dinner the authors shared:

- ➢ New York strip steak grilled with an Italian herb rub
- ➢ Mushrooms sautéed in olive oil and garlic
- ➢ Garden-fresh green beans, steamed and buttered
- ➢ Caprese salad (heirloom tomato, fresh mozzarella, basil leaves, and a honey-basil-roasted garlic vinaigrette)
- ➢ Home-made maple walnut ice cream

Total carbohydrate for the meal: 25 grams. Total Calories: 1000-1200.

HIGH FAT SIDE DISHES:

Sautéed kale with garlic and olive oil

Sadly, in modern America, kale is more often seen than eaten. It's those leaves that are stuffed between the bowls of vegetables and condiments in the typical salad bar. It is great for this because it is a pretty ruffled dark green, and it doesn't wilt for days. However when some bold individual buys it in the grocery and tries eating it, the outcome is usually grim. Why is this? And if it's so bad, why did our grandparents grow it anyway? Kale is a member of the cabbage family, which means that it is frost-hardy and grows well in cool climates.This is actually important information. Its frost hardiness stems from its ability to shift a bit of complex sugar from its roots into its leaves when the weather turns cold.This in turn means that kale harvested in the late fall tastes sweet, in contrast to a more bitter flavor when it's harvested in summer. So the time to eat kale is in the late fall and all winter long. Let them use the summeharvest to make salad bars look appealing. Oh yes, the 'sugar' in the leaves of fall/winter kale only adds up to 3 grams of carbohydrate per half cup cooked serving, so eat it without worry about your keto-adaptation.

Ingredients:
20 or so kale leaves 6'10" long (1-2 bunches in the market)
2 cloves of garlic peeled and chopped (about 2 teaspoons)
3 tablespoons olive oil
¼ teaspoon salt

Rinse the kale in cold water and strip the flesh from thestems, tearing into postage stamp-sized pieces, allow to drain in a colander or sieve. Brown the garlic lightly in the olive oil over medium heat in a large skillet, then add the shredded kale and salt to the hot oil and cover. Reduce the heat to simmer covered for ten minutes, stirring once or twice so it cooks evenly. Serves 3-4, 10 grams of fat per serving. Alternative: rather than olive oil, use an ounce or two of finely chopped sow belly, fried lightly before adding the garlic. This dish can be made with collards as well.

Cucumber yogurt salad

Yogurt-based dressings are common in Greece, the Middle East, and the Indian subcontinent. Yogurt goes well with basil, dill, and lemon, allowing a variety of flavor variations. This recipe uses quite a bit of yogurt relative to the cucumbers, so the result is a bit like cold yogurt soup with cucumber slices. And as an aside, as long as you use 'live culture yogurt', ignore the 'sugars' listed on the yogurt container's nutrition facts label. This is the amount of lactose (milk sugar) in the ingredient milk before the yogurt was made. In live culture yogurt, more than half of this is broken down to lactic acid during the fermentation process that makes yogurt. Unlike lactose, lactic acid (lactate) is easily absorbed by the body without raising your insulin level.

Ingredients:
6 medium or 4 large cucumbers peeled and sliced
4 sprigs of dill, chopped (about 2 teaspoons)
2 cups full fat plain yogurt (**not** the sweetened vanilla flavor)

2 tablespoons fresh lemon juice
2 cloves of garlic, peeled
4 tablespoons olive oil, preferably extra virgin
½ teaspoon salt
¼ teaspoon finely ground black pepper

Put the dill, garlic, olive oil, lemon juice, pepper, and salt in an 8-12 cup food processor and blend with the metal blade until smooth. Add the yogurt and blend briefly until well mixed.Pour the yogurt mix over the cucumbers in a covered bowl and chill.Makes 4-6 servings, each containing 12 grams of fat and 4 grams of carbohydrate.For a nice presentation, serve in small bowls with 5-6 Belgium endive leaves as scoops.

Creamed spinach

Ingredients:
2 pounds fresh spinach
2 medium onions finely chopped
2-3 cloves of garlic finely chopped
1 cup heavy cream
2 tablespoons butter
2 tablespoons olive oil
Salt and pepper
Parmesan cheese (optional)

Wash and drain spinach and remove tough stems. In a large pot, sauté onions and garlic in butter and olive oil until translucent. Add spinach, constantly stir and pressdown until leaves are wilted. Add cream and cook until desired texture. Add salt and pepper to taste. Top with shaved parmesan cheese (optional).

French Fried Green Beans

Finger food to go with a steak or burger, or just by themselves for the fun of it!

Ingredients:
1 pound of fresh green beans
1 teaspoon coarse sea salt
½ teaspoon black peppercorns or rose peppercorns
¼ teaspoon garlic powder
½ teaspoon dried Italian seasoning mix
1 egg white

Pre-heat a deep fat fryer to 240 F –preferably filled with high oleic safflower oil
Rinse green beans, trim, and pat dry on a towel
Grind spices together in a mortar and pestle
Whip egg white until foamy, then coat the green beans in egg,

Put egg-coated beans in a 1-qt plastic bag and dust with ground spices, shake vigorously, and drop into hot oil.
Fry for 2-3 minutes. Remove when the egg coatinust starts to brown.

Tomato bisque

For those of us who grew up thinking that soup is bor in a can, it's a delightful discovery how good homemade soups can be, and how easy they are to make.Also, if you make your own soups from your homemade broth, a serving of soup doubles as a serving o broth as well. This recipe is best if you have ripe tomatoes and fresh basil from your garden, otherwise use plum (roma)tomatoes from the store.

Ingredients:

1 large onion sliced ¼ inch thick
6 large or 12 small tomatoes (the total volume should be 2-3 cups)
10-15 fresh basil leaves
¼ cup light olive oil
½ teaspoon finely ground black pepper
4 cups home-made chicken broth
1 cup medium (25% fat) or heavy (40% fat) cream

I. Rinse the tomatoes and basil leaves in cold water andrain on a towel. Put olive oil and onions in a medium (3-4 quart) pot and brown over medium heat for about 5 minutes. Theonions should end up light brown, soft, and translucent. Cut the tomatoes in half and add them along with the basil leaves and pepper. Cover and simmer for 10 minutes, until the tomatoes are soft and cooked through.
II. Allow to cool for 5 minutes and place tomato/onion mixture in a food processor and blend for 60 seconds, pulsing frequently to be sure all large hunks are chopped fine.
III. Rinse the cooking pot, place a large sieve over it, anstrain the blended tomato onion mix through it,discarding any solids that don't go thru the sieve.
IV. Depending on how smooth you want the texture of the soup, you can choose the sieve mesh size from coarse to fine.
V. Add the chicken broth to the tomato onion puree and warm over low heat. Heat until it just starts to steam (160-170 F) -- don't let it boil!
VI. Take soup off the heat and whisk in the heavy cream.
VII. Salt to taste (the amount depends if your chicken broth was salted).
VIII. Serve warm. Serves 6. Provides 20-25 grams fat and 5 grams carbohydrate per 10 oz serving.

Wedgie

Remember when a cheese sandwich and an iceberg lettuce wedge with ranch dressing was lunch? Note some people look back fondly at that iceberg wedge as a comfort food. Well, here's a modern version, dosed with enough other stuff that it actually has measurable nutritional value.

Ingredients:
1 head of iceberg lettuce, stripped of wilted outeleaves, rinsed and drained
½ cup of crumbled blue cheese
½ cup of bacon fried lightly crisp and chopped
1 cup of sliced or diced fresh tomatoes
1 cup of sliced or diced cucumber
1 cup of yogurt blue cheese dressing (recipe below).

Slice the lettuce into quarters through the stem and remove the core from each piece.Slice each quarter again to make equal wedges (eights)and lay the two narrow edges together in the center of salad plate.Arrange the toppings in the 'central valley' – for example put cucumber and tomatoes on either end and the blue cheese and bacon in the middle. Drizzle 4 oz of the yogurt blue cheese dressing over the top when served. Serves 4. Fat content 30 grams per serving.

High Fat, Moderate Protein, Low Carb Breakfast Smoothies

Recipes for 'low carbohydrate' smoothies abound, but most are also low in fat and assume that anything under 200 Calories from sugars qualifies as 'low carb'. Here are two basic recipes that provide enough fat and protein to keep you satisfied until lunch, and both come in at or under 10 grams of carbohydrates. Note that you have your choice of sweeteners, but the argument for adding some xylitol to the mix is that it does not raise your insulin level, provides useful energy, and protects your dental health.
Also note that there are lots of different protein powders for sale, but most whey products are flavored and sweetened. Shop until you find unflavored whe powder with the lactose removed – the label should indicate about 15 grams of protein and less than one gram of carbohydrate per serving. Do not buy so protein powder or whey/soy mix, as the soy does not dissolve well into the smoothie. This whey powdelooks expensive (about $1 per 15 gram serving) but this is the same amount of protein as you get from 2 eggs.

Breakfast Berry Smoothie Ingredients:

Ingredients:
3 oz fresh or frozen (unsweetened) berries(strawberries, blueberries, or raspberries)
¼ cup whipping (or heavy) cream
1 tablespoon light olive oil
2 tablespoons unflavored whey protein powder (delactosed)
sweetener of choice (e.g., 1 tablespoon xylitol and 1 packet Splenda)
2-3 oz ice
Blend the ingredients at high speed until smooth (30-60 seconds)

Protein 15 grams, Fat 25-30 grams, Carbs 10 grams,Calories 330-380

Breakfast Mocca Smoothie Ingredients:

Ingredients:
4 oz coffee ice (frozen in ice cube tray – if frozen as big lump in a cup or bowel, it's hard to blend)
¼ cup whipping or heavy cream
1 tablespoon unsweetened cocoa powder
1 tablespoon light olive oil
2 tablespoons unflavored whey protein powder (delactosed)
sweetener of choice (e.g., 1 tablespoon xylitol and 1 packet Splenda)
Blend the ingredients at high speed until smooth (30-60 seconds)

Protein 15 grams, Fat 25-30 grams, Carbs 6 grams, Calories 310-35.

High Mono Dressings

Yogurt blue cheese dressing

Commercial blue cheese dressings abound out there, so why should I make my own?Answer: Better taste, better nutrition, and the right kind of fat. And if you need another reason, this recipe can be made in quantity and stored in your freezer in single serving doses. Spend 15 minutes making a batch now,and get 10 servings whenever you want them later.

Ingredients:
2 cloves of garlic
10 fresh basil leaves
2 tablespoons fresh lemon juice
¼ cup olive oil
4 cups plain unsweetened yogurt (full or low fat, not fat-free and definitely **Not** vanilla!)
8 oz crumbled blue cheese
1/8 teaspoon finely ground black pepper
1 teaspoon salt

Put the garlic, basil, lemon juice, olive oil, pepper, salt,and 4 oz (half) of the blue cheese in a blender or food processor and process until smooth. Add the yogurt and pulse until well mixed. Add the other 4 oz of blue cheese and process briefly to mix (but not blend).Parcel out ½ cup units into snack zip-lock bags,squeezing out any extra air. Put in a container and freeze. When needed, take individual ½ cup units out of the freezer and thaw for a few minutes in cool water.Makes 10 half-cup servings, each containing 16 grams of fat.

Honey basil dressing

This dressing is made with real honey, but since it is mostly olive oil, the sugar content of the dressing preserving is quite low. This dressing keeps well in the refrigerator, and the roasted garlic is an excellent emulsifier, so it usually doesn't separate like most oil and vinegar concoctions.

Ingredients:
10 cloves of roasted garlic
20 fresh medium or 10 large basil leaves
¼ cup unsweetened rice vinegar (find it in the Asian foods section of your grocery)
¼ cup honey
2 packets of Splenda or 2 level tablespoons xylitol
1 cup light (not extra virgin) olive oil
½ teaspoon salt

The best way to roast garlic is to get a covered ceramic garlic roaster, slice the tops off a full garlic bulb, drizzle it with a tablespoon of olive oil and roast in the over for 45 min at 400 oF. Alternatively use a metal muffin tin, place the trimmed garlic bulb base down, drizzle with olive oil, cover each bulb with aluminum foil, and bake for 30-40 min at 400 oF. When done, the garlic cloves are soft and starting to push up out of the holes you cuin the top of each clove.

Put the roasted garlic cloves, basil leaves, rice vinegar and honey into a food processor or blender and process until very smooth (at least 2 minutes). Add the olive oil, sweetener, and salt. Blend until well mixed.Refrigerate extra in a closed container. Makes 12 one oz servings, each containing 20 grams of at and 5 grams of carbohydrate.

Sun-dried tomato caper dip (tapenade)

This dip is usually used on bread, but it is great with fresh vegetables, particularly Belgian endive. It is nice when made with commercial sun-dried tomatoes, but iis outrageously good when made with your own homegrown ripe tomatoes that you dry yourself.

Here's a simple way to dry tomatoes. Using a sharp knife, slice ripe tomatoes in ¼ inch thick slices blot dr on a paper towel, and lay on waxed paper in a dish it he bottom of the microwave. If you have a microwave shelf, cover it with more tomato slices as well. Run the microwave for 5 minutes at 30% power (defrost) and then for 60 minutes at 10% power. A 1000 Watt microwave puts out 100 Watts at 10% power, so it's making about as much heat as a 100 Watt light bulb,and the tomato slices should be slightly warm but not hot. Check the tomatoes after each hour, turning and rearranging as needed to help them dry evenly, repeating the same 5/60 minute heating cycle each time. This will dry 3-4 pounds of tomatoes in about 5 hrs. When done, they should be leathery in texture and still dark red. Do not dry them to black crispy wisps.

Ingredients:
3 oz of dried tomatoes (from 1.5 to 2 pounds of frestomatoes)
2 oz non-pareil pickled capers, lightly rinsed and rained
20 fresh basil leaves
3-5 cloves roasted garlic
1 packet Splenda or one level tablespoon xylitol
2 tablespoons unsweetened rice vinegar or wine vinegar
1 cup light olive oil
Add everything together in a food processor and blend until the tomato and basil are down to fine bits. The flavor is best if made at least an hour before serving. Remaining dip can be refrigerated for a week.

Each tablespoon contains 10 grams of fat.

Desserts

Maple walnut ice cream

Delicious, easy to make, and guilt free ice cream.

Ingredients:
½ cup English walnuts
2 tablespoons butter
2 tablespoons real maple syrup
4 cups heavy or whipping cream
2/3 cup xylitol
8 packets Splenda
2-3 drops of artificial maple flavor

Chop the walnuts to pea size. Put the nuts in a small frying pan with the butter and heat over low heat until the nuts just start to brown. Add the maple syrup to nuts and butter and stir gently over low heat until the syrup thickens and coats the nuts. Take off the heat and allow to cool. When cool, the nuts should harden into firm sticky lumps.

Mix the cream and sweeteners together and stir with spoon until all are dissolved. Add the maple flavor and put in an ice cream maker, churning until it is thick enough to form a stable mound on a spoon. Break apart the lumps of sugary nuts and drop them into the ice cream and churn only until well distributed. Put in the freezer to firm up.

Makes 10 half-cup servings, each containing 25-40 grams of fat and 4 grams of carbs.

Blueberry cheesecake

Cheesecake would be a great source of dietary fat if it weren't for the crust and all of the sugar in it. So here is a crustless cheesecake made without any 'sugar', i.e.the stuff that raises your insulin level.

Ingredients:
2 packets plain unsweetened gelatin
1 cup xylitol (alternative ½ cup xylitol and 6 packets Splenda).
1 ½ cups water
12 oz creamed cheese
1/4 cup light olive oil
2 teaspoons vanilla extract
2 cups fresh blueberries (or sliced strawberries)

Heat the water to boiling, remove from heat an sprinkle the gelatin powder in while stirring vigorously until it is dissolved (clear). Put the cream and cheese, olive oil, xylitol, and vanilla in food processor, pour in the hot gelatin solution, and process until smooth.Rinse the blueberries, pat dry, and put in the bottom oa 9-inch pie plate. Pour the still warm gelatin-cheesemix over the berries and chill in the refrigerator until isets (30-60 min).
Makes 12 4-5 oz servings, each with 15 grams of fat and 4 grams of carbohydrate.
Alternatively, distribute the berries into 6 'snack size 'Zip-Loc' bags and pour in enough cheesecake liquid to fill each bag. Squeeze out any air, seal immediately, and refrigerate). The sealed bags keep for up to a wee refrigerated and a day unrefrigerated.

Summary
We hope you now have a better appreciation of how imaginative you can be with using fat to create appetizing dishes. Yes, adhering to a low carbohydrate diet does require you to give up most of those sweets and starches that once controlled you, but that's a small sacrifice when you consider what you're trading up to. Now that you are keto-adapted, using traditional fats like butter, olive oil, heavy cream, cheeses, and creacheeses in combination with a variety of vegetable dishes are highly encouraged and part of what makes low carbohydrate diet lifestyle enjoyable and sustainable".[62]

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[62] Phinney, Stephen & Volek, Jeff. The Joy of Cooking (and eating) fat. *Art and Science of Low Carbohydrate Living. 2011. Chapter 17, pp. 23-36.*

What's Different in New Atkins? [63]

So just what has changed and what is new? Ultimately, New Atkins New You sets out to respond to the negative criticism that's been thrown at the diet over the years by addressing the key concerns that health professionals have highlighted.

Concern 1 – **Lack of Fruit and Vegetables**

The response:
New Atkins New You gives far more detailed information and lists of the vegetables that can be eaten right from the start of the plan.
Included in the daily 20g net carbs, it recommends that 12-15g come from 'foundation vegetables meaning it's now relatively easy to get 5-a-day! Alfafa sprouts, artichokes, avocado, asparagus, aubergine, bamboo shoots, Brussels sprouts, beansprouts, broccoli, cabbage, cauliflower, celery, celeriac, chicory, courgette, cucumber, endive, French/green beans, fresh herbs, fennel, kale, leeks, lettuce, mangetout, mushrooms, mixed leaves, olives, pak choi, peppers, radish, rocket, onions, spinach, sugar snap peas, tomatoes and watercress.

- As an example, you could eat the following in a day:
- ½ avocado –1.8g carbs
- 80g broccoli –1.7g carbs
- 80g cauliflower –1.2g carbs
- Salad made from 80g iceberg lettuce, 1 tomato, 6 radishes and ½ red pepper – 6.6g carbs
- 80g red cabbage – 2.1g carbs

This totals 13.4g carbs so it's well within the daily carb allowance but easily provides 5-a-day.

WLR says:
It's good to see the plan places more emphasis on the vegetables that can be eaten so it's easier for dieters to achieve 5-a-day. It's worth bearing in mind though, that health professionals agree we should eat a rainbow of colours to ensure a good range of nutrients.
Many of the veg allowed are green with fewer other colours. In particular, no orange or yellow vegetables are included. These tend to be good sources of carotenoids such as beta-carotene, which the body uses to make vitamin A (although green veg do still include this important antioxidant). Adding more variety also helps to prevent diet boredom from setting in.

[63] Juliette Kellow BSc RD, *New Atkins for a New You - The New Atkins Diet,* Weight Loss Resources, United Kingdom. http://www.weightlossresources.co.uk/diet/atkins_diet/new-atkins-new-you-review.htm

Concern 2 – **The Atkins Diet is a Fad Diet**

The response:
New Atkins New You gives lots of details of studies showing the new Atkins diet is a suitable eating plan to for life providing additional practical advice on how to achieve this.
Most health professionals would agree that this remains a fad diet as it recommends avoiding an entire food group.
It recommends that a daily multivitamin with minerals, including calcium and magnesium be taken - not something people need to do if they're eating a balanced diet including a wide range of foods.

The response 2:
Despite the scientific studies cited in the book, we still believe the Atkins diet is a quick fix, fad diet and not one that's sustainable for life.
Ironically though, the book is still selling itself partly on the promise that you can "Lose up to 15lb in 2 weeks", which most people, including health professionals, would consider to be a quick fix.

Health professionals in the UK continue to recommend a balanced, varied diet that avoids cutting out major groups of food and results in a slow, steady weight loss of no more than 2lb a week.
The British Dietetic Association provides information on how to spot a fad diet and recommends staying away from diets that:

Promise a quick fix
suggest easy, rapid weight less of more than 2lb a week
promote the avoidance or severe limitation of a whole food group such as carbohydrate foods or dairy foods (and suggest large doses of vitamin and mineral supplements as a replacement)
make claims that sound too good to be true.
In our opinion, the Atkins diet does all of the above and so can be considered a fad diet. As for following a low-carb diet forever? Well, health professionals are certainly starting to recommend that we eat smaller portions of carbs and opt for healthier, unprocessed ones to help control our weight. But the bulk of our diet should still be made up of fruit, veg, potatoes, pulses and wholegrain carbs such as wholemeal bread, brown rice, wholegrain cereals, wholewheat cereals and other grains such as barley, quinoa and bulgar wheat.

Concern 3 – **The Unpleasant Side Effects**

The response:

New Atkins New You explains that consuming carbs makes us retain water so switching to fat burning (by cutting carbs) has a diuretic effect meaning we excrete more salt along with fluid. It's this loss in fluid and salt that leaves us with unpleasant symptoms.
The solution? The book recommends drinking more water. But it also recommends adding half a teaspoon of salt to your diet each day.

The response 2:
Drinking more water is great but, adding salt to your diet? In the UK, much work has been carried out by the Food Standards Agency (FSA) to raise awareness of the importance of reducing daily intakes of salt to no more than 6g a day from an initial high of around 9.5g. It therefore seems incredible – and highly inappropriate – that a diet plan should actually be recommending an increase in salt, and a considerable increase at that!

Food manufacturers have also been working hard to reduce the amount of salt in their products so that as a nation, we find it easier to limit our intake to no more than 6g a day. The key advice is to ditch the salt pot altogether, to eat fewer salty foods and to check the salt content of different products and go for those with the lower salt content.

Half a teaspoon (2.5g) of salt provides more than 40% of the maximum recommended amount of 6g – and so is not advised. One of the better aspects of the original Atkins diet was the fact that cutting out certain carb-rich foods such as bread, some cereals, baked goods, crisps, ready-made sauces, ready-meals, pizzas and takeaways meant a reduction in salt intakes. The advice to add more salt back into the diet is not something that health professionals would recommend and should be avoided.

Concern 4 – **Atkins Not a Suitable Diet for Vegetarians**

The response:
New Atkins New You provides more detail on how vegetarians can still follow the new diet.
More information on the non-animal sources of protein that can be eaten such as eggs, cheese, soya products, nuts, seeds, rice cheeses, pulses and higher-protein grains such as quinoa.
You can also start the diet in phase 2 or 3 so you can eat more carbs.
There are 12 weekly meal plans for vegetarians or vegans based on different carbohydrate intakes.

The response 2:
People following vegetarian and even vegan diets have now been catered for more fully in this diet, which traditionally has been promoted at meat lovers. However, with a restriction on the amount of fruit, veg, pasta, rice, bread and pulses that can be eaten – which often form the mainstay of many non-meat eater's diets – diet boredom may quickly set in.

Concern 5 – **Atkins Diet is Too Boring and Complicated**

The response:
New Atkins New You provides more extensive lists of the foods that can be eaten. For example, rather than sticking to beef, lamb and pork, ingredients such as duck, pheasant, poussin, quail, veal, venison and even ostrich are identified as foods that can be included freely.
Coffee is no longer limited to just one cup a day as new research indicates it may mildly help to burn fat.
Alcohol can now be introduced in phase 2.
The book provides 24 weekly meal plans based on different carbohydrate intakes (including 12 for vegetarians and vegans).
There's eating out advice for different cuisines.
Lots of low-carb recipes for sauces, dressings and marinades.
There is more choice as to which phase of the new Atkins diet you start with depending on factors like your age, your activity levels and the amount of weight you want to lose etc.
For example, if you have less than one stone to lose, you can start in Phase 2, whereas if you are a yo-yo dieter it's better to start in Phase 1.

The response 2:
There is certainly a lot more practical advice to make the diet easier to follow.

Concern 6 – **Atkins Diet Too High in Fat**

The response:
New Atkins New You explains that according to research saturated fat on its own doesn't increase the risk of heart disease highlighting that saturated fat only poses a risk to heart health when it's combined with high intakes of carbs.
Fat is the primary source of fuel for the body when there are no carbs to utilise, dieters burn more saturated fat and store less of it. So if carb intakes are low, there's no reason to worry about saturated fat. In fact, the book goes as far as saying, "This way of eating can significantly reduce your chances of developing heart disease."

The response 2:
It's still widely accepted that high intakes of saturated (bad) fat – without much concern as to some other components of your diet – are linked to heart disease and so the high intake of saturated fat in this plan remains controversial amongst health professionals.

There's still no advice to reduce fat in the new Atkins diet book. It's recommended that a typical days intake of fat might come from 2tbsp oil, 1tbsp butter, 25-30g cream, 55g cheese, 2-3 eggs, 2-3 servings of meat, poultry or fish, 10 olives or ½ avocado and 55g nuts or seeds (after Induction). The book also actively recommends avoiding a low-fat Atkins diet, saying that fat aids satiety and provides sufficient calories to prevent metabolism from slowing down.

In the past 18 months, the Food Standards Agency has been promoting the importance of eating fewer foods that are rich in saturated fat to help reduce our risk of heart disease and has been working with manufacturers to encourage them to reduce the amount of saturates in their products. Incidentally, the typical day's intake of fat (based on 2tbsp sunflower oil, 1tbsp butter, 30g double cream, 55g Cheddar, 2 eggs, 175g rump steak, 1 chicken breast with skin, ½ avocado and 55g mixed nuts) provides 163g fat and 56g saturates – that's more than double the recommended daily fat intake of 70g and almost three times the recommended daily saturated fat intake of 20g.

It's also important to remember that high fat foods tend to be the highest in calories – the above intake of food alone provides almost 2,000 calories so it's hard to see how weight loss would occur on an intake like this. To guarantee a slow, steady weight loss, sticking to around 1,300-1,500 calories is ideal – and one of the easiest ways to do this is to cut back on the amount of unecessary and unhealthy fat in the diet.

Concern 7 – **High Protein Diets can Cause Kidney Disease etc.**

The response:
New Atkins New You claims this isn't a high protein diet but that it's based on an optimal protein intake. It also refutes claims that high protein diets can damage kidneys or negatively affect the bones through increased calcium excretion saying that studies on this subject are limited or flawed.
The Book provides more detailed information on the quantities of protein that dieters should consume based on their height. For example, a woman of 5ft 6in should have between 75-156g protein a day – the

range is wide allowing dieters to choose the amount that suits their needs.
It also acknowledges that if weight loss is slow, protein intakes may need to be cut back a little.

The response 2:
The suggested intakes of protein are still much higher than those recommended for adults in the UK. For example, the guideline daily amount of protein for women is 45g and for men, 55g. Research increasingly shows that good intakes of protein can help to improve satiety – that feeling of fullness at the end of a meal, which can help to prevent us snacking. So eating protein-rich foods with each meal is certainly a good idea.
Further research also shows that protein combined with fibre is actually the perfect hunger-fighting combination. Eggs with wholegrain toast for breakfast, a large chicken salad and fruit for lunch, and a beef and vegetable stir-fry with brown rice for dinner are great meals for keeping hunger at bay.[64]

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[64] Juliette Kellow BSc RD, *New Atkins for a New You - The New Atkins Diet,* Weight Loss Resources, United Kingdom. http://www.weightlossresources.co.uk/diet/atkins_diet/new-atkins-new-you-review.htm

Our studies suggest that the major protective effect of ketosis is a significant reduction in glucose metabolism. This is the opposite to diabetes.

~ Dr. Charles Mobbs[65]

During the periods of starvation or fasting, the human brain can very easily switch over to using ketones as an alternative to glucose. As we age, we tend to use less glucose and switch over to alternative fuels in the brain. If we are on a high-carbohydrate diet, which suppresses ketone production, and have no other dietary source of ketones, we cannot expect that our brains will function as well. So many people have at least some degree of insulin resistance, and ketones could provide alternative fuel to cells that are not taking in glucose well, allowing for better cell function and ultimately healthier organs, including the brain.

~ Dr. Mary Newport

I think it has been shown fairly conclusively that it is only the high-fat, not the high-protein, diet that produces the greatest health benefits in combination with a low carbohydrate intake.

~ Dr. Ron Rosedale

Ketones are an efficient and effective fuel for human physiology without increasing the production of damaging free radicals. Ketosis allows a person to experience non-fluctuating energy throughout the day as well as enhanced brain function and possibly resistance to malignancy.

~ Dr. David Perlmutter

Ketones themselves are a great, and in many tissues - such as the brain - far better, fuel sources than the alternative glucose. I have always found beneficial answers to questions pertaining to health by studying the biology of aging. That is really how I became involved in treating diabetes with a high-fat diet. I became interested in type 2 diabetes as a model for accelerated aging. For over twenty years I have talked about the strong connection - perhaps even causation -

[65] J. Moore, E.C. Westman, MD., *Keto Clarity: Your Defining Guide to the Benefits of a Low-Carb, High-Fat Diet.* 2014. Victory Belt Publishing Inc. Las Vegas.

between a high-fat, moderate-protein, very low-carbohydrate diet and slowing down the biological rate of aging.

~ Dr. Ron Rosedale

Most doctors are not aware that a ketogenic diet lowers insulin levels and that this directly affects the kidney's handling of sodium and water. Low insulin levels are a signal to the kidney to excrete sodium and water, whereas the high insulin levels associated with a high-carbohydrate diet are a signal to retain sodium and water. Physicians are taught to prescribe diuretics and advice salt restriction in sodium- and water-retaining states such as hypertension and congestive heart failure. But they should be taught the much more powerful effects of restricting carbohydrates.

***~** Dr. Keith Runyan*

Thousands of people are on low-carb diets, and with a substantial part of the medical community looking for harm, none has been found. This is strong, probably irrefutable, evidence that low-carb diets are safe. So, we're all engaging in doing the experiments.

~ Dr. Richard Feinman[66]

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[66] J. Moore, E.C. Westman, MD., *Keto Clarity: Your Defining Guide to the Benefits of a Low-Carb, High-Fat Diet.* 2014. Victory Belt Publishing Inc. Las Vegas.

Conclusion:

"Physiological/metabolic factors inclusive of obesity are also major contributors to degenerative arthritis with or without injury especially to the joints of the lower extremity.

It is felt that genetic factors account for 80% of a person's tendency to develop obesity. Genes, which are called "thrifty genes", contribute to morbid obesity. The thrifty genes were selected out eons ago in individuals that could lay down fat as fast as possible, much like bears prepare to hibernate. This thrifty gene pool was able to propagate the race due to the fact that they basically lived longer due to an enhanced ability to retain weight during the early stages of life, and probably during the summer season during the summer season when food was more abundant.

The thrifty genes are designed to protect us from starvation by allowing us to store large amounts of energy in the form of fat when food is abundant. Fat is a storage food and when times are lean, fat is metabolized to energy to run the body's normal functions.

During our current era, it is the first time in human history that food has been so abundant. The age-old advantage of thrifty genes has been influenced by our unique environment of abundant food sources. Since the regulation of body weight has a genetic component, the genes confer the potential for obesity. The environment determines whether, and to what extent, the potential is realized. In addition, it has been shown that for every pound over the ideal body weight abnormal forces are generated at both the hip and knee. At the knee, the abnormal forces are estimated at 3 – 5 times normal as relates to the number of pounds actually over the patient's ideal slender weight. Knee joints are then more easily damaged due to the excessive mechanical forces placed against the joint with everyday living including turning, twisting, squatting, and bending activities at the knees.

While the actual body weight or size of a patient is an obvious contributor to damage above the knee joint, the secondary metabolic abnormalities produced by excessive obesity has led to the metabolic syndrome where Western cultures are experiencing a sharp increase in obese, diabetic individuals

including younger-aged obese children. The incidents of type II diabetes in the younger child and adolescent child is increasing dramatically.

It is a scientific fact that patients who maintain a moderate to excessive amount of body weight above the ideal, that approximately 80% of these individuals will develop type II diabetes. The onset of diabetes starts at an early age if one has eaten the traditional American diet riddled with junk food. Junk food, by definition, is most food within the middle aisles of the supermarket where one finds chips, donuts, processed foods, etc, and not the periphery where fruits, vegetables, and meats are located.

There is a metabolic answer to the obesity problem, which is based in biochemistry. Simply put, when an individual becomes too heavy and fat-laden, the internal metabolism is changed pathologically. Just envision the inside of the body being covered in maple syrup. Because when excess glucose (sugar) is ingested, the body does not have the ability to use the vast amounts of glucose that is overwhelming the metabolic system and glucose (sugar) is progressively deposited internally, and the term for that is glucose toxicity. Insulin is the hormone responsible for deposition of excess glucose into the cells and fat storage. Over the years, excessive insulin is produced and eventually the pancreas is unable to continue to generate excessive insulin to handle the large sugar load and starts to fail, leading to prediabetes and Type II Diabetes and finally Type 1 diabetes.

It is estimated that 80% of pancreatic cellular death occurs when the patient finally converts to type II diabetes. This only leaves 20% of the normal gland to compensate for THE excessive serum glucose.

The metabolism of glucose toxicity leads to diabetes, increased risk of cancer, and premature death with malfunctioning of the immune system due to the cell membrane damage with involvement with too much glycation which is another word for glucose toxicity. I have called this the **Maple Syrup Syndrome.** Glucose in excess lines the surfaces of the cell membranes, blocking the normal cellular function. This event occurs in all cells of the body, including cancer fighting cells, lymphocytes.

Increased amounts of what is called advanced glycolytic end products (AGE) are deposited as a result of the breakdown of excessive glucose within the body into the soft tissue and also at the cellular level. Fat is deposited from glucose metabolism in both the intracellular and extracellular spaces.

Excessive circulating glucose in the system with the advanced glycolytic end products produces serious damage to the lining membrane of the vessels causing premature strokes and heart attacks and leading to high serum cholesterol and atherosclerosis.

Other early diabetic abnormal physical findings include abnormal pigmentation in the armpits, a fatty hump at the posterior aspect of the proximal thoracic spine just below the back of the neck, scar formation in the hands called Dupuytren's contractures, abnormal tightening of the tissues at the feet producing hammer- and claw-toe deformities, just to name a few.

AGE's act as inflammatory markers and produce a generalized systemic inflammatory response in the body, which eventually affects all organ systems and produces, in many patients, a chronic pain syndrome. The abnormal glucose deposition on the surface of the cells is currently able to be tested by a test called the Hemoglobin A1c test, which evaluates the red blood cell surface membrane as to the percentage of glucose embedded on and in the membrane. A whole system of evaluation of the successive treatment of early and late diabetes is based upon this new blood study called the Hemoglobin A1c test.

It should be noted that the dysfunctional cells in the body produced by the diabetic process also become functionally abnormal and many researchers feel that the altered cells are the progenitors of various types of cancers. Some of the cancers in this category include bladder cancer and leukemic syndromes.

How does this abnormal metabolic state in diabetic patients affect the knee?

Based on reviewing the literature, it is my opinion that the knee is weakened in these metabolic syndromes such as diabetes and that the vascularity of the bony structure is compromised. It is a well-known fact that diabetic patients do suffer from osteoporosis which is softening of the bone and lack of calcium. The exact mechanism of this phenomena is not well understood but is probably vascular in origin.

Recent literature suggests that obesity itself affects the knee by changing the metabolism inside the knee to produce more lytic chemicals that degrade the articular cartilage and produce premature degenerative changes in addition to the abnormal mechanical forces generated by excessive body weight that wear out the articular cartilage due to increased stress on the cells that can only

take so much pressure and lead to cell death and premature arthritis due to the abnormal stress.

The keys to a healthy knee are multifactorial. To avoid knee-related problems, we should be concerned as to the types of activities we engage in from an early age. Activities such as contact football, rugby, soccer, basketball, etc. do produce excessive force at the joint regions. And if the patient is genetically inclined or metabolically pathologic, extensive exercising will lead to premature posttraumatic arthritis.

Probably the most important caveat is to lose weight down to our lean body weight and eat a low carb high fat diet, or Ketogenic diet, or modified fasting regimen (prefer to the article on diet and nutrition). All should include calorie reduction to fit the estimated lean body mass (we have a formula to use).

It should be noted however that the generally overweight American professional football linemen have been reviewed in a Stanford study and documented that the linemen at the NFL level had an average age of death of 55. Most professional football players only retire from football after they have suffered serious injury and/or disability, which affects them for the rest of their shortened lives.

It is my job as a physician and an orthopedic surgeon to understand this process and to educate my patients so they may reverse their abnormal metabolisms and the excessive joint forces which produce premature arthritis and serious disability, especially as it relates to the knee.

There is still much to understand regarding the relationship between weight loss/gain and OA incidence progression but an overall proactive societal strategy and approach to diet, physical activity, food marketing and agriculture is required.

Excessive body weight is literally killing us by slowly degenerating our joints both mechanically and metabolically. This process can be stopped with a healthy diet and in some cases the process can be reversed if caught early enough. Recent science has solved the mystery.

We must learn what to eat and why and understand the typical american diet which is high in carbohydrates (sugar), low in fat, and very high in protein which is detrimental to our health.

We should all be eating a healthy diet which is very low in carbs, moderate protein, higher in healthy fats with a special emphasis on understanding our personal caloric needs.

We must learn what our ideal weight is as well and this will be a subject of another paper.

This paper is a brief review of the scientific literature about strategies available to lose weight, live longer, reduce the incidence of joint osteoarthritis and avoid the need for aggressive surgical treatment for our degenerating joints and especially the knee in particular.

We will be offering counseling on diet and exercise. A scientific plan will be provided for you. If interested, please contact my office and schedule a medically supervised health and fitness assessment appointment which will include a spine and joint health assessment evaluation.

This program will not be covered by health insurance."

~ G. Charles Roland, MD

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