Optimising nutrition, managing insulin

Summary

1. Recent research from the University of Sydney indicates that the food insulin index may be better way to calculate insulin requirement for compared to carbohydrate counting or the glycemic index.

2. Analysis of the food insulin index data indicates that the insulin demand of a food is related to net carbs plus approximately half of the protein.

3. This understanding of the effect of carbohydrates, protein and fibre enables us to calculate the insulin load using the following formula:

   \[ insulin\ load\ (g) = carbohydbrates\ (g) - fibre\ (g) + 0.54 \times protein\ (g) \]

4. Restricting the overall insulin load of the diet to around one hundred grams per day will enable most people to achieve excellent blood glucose control and attain light nutritional ketosis.

5. Diabetics and people wanting to reduce their insulin levels should preferentially select foods with the lowest percentage of insulinogenic calories using the following formula:

   \[ \% \text{insulinogenic}\ calories = \frac{[carbohydrates - fibre + 0.54 \times protein] \times 4\ cal/g}{total\ calories} \]

6. Fats and oils, butter and cream have the lowest proportion of insulinogenic calories, however consuming these foods alone is unlikely to provide adequate vitamins, minerals and protein.

7. This paper outlines a quantitative system for the ranking of foods that can be tailored to an individual’s goals, metabolic health and financial situation in accordance with the following metrics (e.g. weight loss, diabetes / ketosis or athletes / metabolically healthy):
   - proportion of insulinogenic calories,
   - nutrient density per calorie,
   - fibre per calorie,
   - nutrient density per dollar,
   - nutrient density per kilogram, and
   - cost per calorie.

8. Optimal nutrition can be provided using a range of macronutrient profiles. When we consider the insulin load, nutrients and protein quality the highest scoring dietary approaches used between 50 to 80% fat, 13 to 35% protein and 7 to 16% carbohydrates. Within this window we can then refine the diet based on the goals of the individual whether they be weight loss, blood glucose control / ketosis or athletic performance.
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1 Background

1.1 Introduction
I’m an engineer with an interest in nutrition who tries to optimise things numerically. My wife is a type 1 diabetic and I have a genetic predisposition for type 2 diabetes and obesity. We have also seen dramatic improvements in the health and happiness of our two kids with improvements in our diet. For me this is personal, and I’m passionate. I hope that our journey can help to shortcut your path to optimum health.

There are always new things to learn in the world of health and nutrition. The range of sometimes conflicting ideas makes it difficult to craft a cohesive dietary narrative to achieve health and vitality. The aim of this document is to consolidate a spectrum of ideas into a system that will enable an individual to tailor their food choices to their goals whether they be weight loss, blood glucose control or athletic performance.

The system document builds the LCHF, paleo and ketogenic frameworks to minimise the negative effects of high blood glucose and excess insulin while maximising nutrition through eating real, whole luxurious and delicious food.

My hope is that this information will be useful and help a people short cut their journey to health and vitality.

1.2 Feedback so far
To date I have shared this document with a small group of people. The feedback so far has been encouraging.

“I just scanned through the draft document. It’s fantastic! All doctors, dieticians and diabetes educators need to read this!”

Lisa Scherger, The Diabetic Alien and My Healthy Type 1 Son

“You have some great information here. If you’re ever interested in reaching a wider audience, I’d be happy to publish some articles on my site.”

Craig Clarke, RuledMe

“This is excellent work… One of the problems with insulin index is that there is virtually no data other than S. Holt’s paper, and she never really follow it up.”

Dr Jason Fung, Intensive Dietary Management

From Marty Kendall comes a stunning document that will help all to manage their insulin levels. Carb is the major provoker, but keep an eye on yer protein too. As always, fat is the king of energy sources, the cleanest burning fuel for humankind - once you keep the demon carb under control.
that is. I will be using this as my go-to reference on the subject, and you should too! How has Marty managed to produce such an excellent document we wonder? Well, the fact that he’s an engineer ‘associates’ with the standard of insight achieved. And in this case the relationship is causal too!

Ivor Cummings, The Fat Emperor

Hey Marty, I read your nutrition article. Great work. Really enjoyed it.

Dr Troy Stapleton

Epic work Marty.

Sam Feltham, Smash the Fat

Brilliant post and excellent website.

Franziska Spritzler, Low Carb Dietician

Super awesome, nice work Marty Kendall. Shout-out to my fellow engineers engineers!!

Ted Naiman, Burn Fat Not Sugar

This is one of the most impressive works that I’ve read since finding Dr. Richard K. Bernstein, MD Diabetes Solution. I really appreciate the time and effort you put into analysing real data to draw clear-cut and defendable conclusions. This is a pleasant change to drawing conclusions from population studies that allow you to reach whatever conclusion the author is promoting. Once again, well done!!!

Steve Cook

You have put a lot of work into this. Hope you get the response you are looking for.

Helen Kendall (aka mum)

1.3 Paleo, obesity and insulin resistance

You’ve probably heard it said that our ancestors didn’t eat a particular macronutrient ratio that kept them healthy, but rather they avoided obesity and the diseases of modern civilisation by consuming sugar and carbohydrates the natural packaging that it came in. Our ancestral diet included a diverse range of plant and regularly provided more than 100g of dietary fibre per day.¹

¹ http://www.nature.com/ejcn/journal/v61/n1/full/1602486a.html
I recently came across a series of enlightening videos by Doctor Jason Fung\(^2\) in which he highlighted research on the “food insulin index” (FII) which that carbohydrate alone is not a fantastic predictor of insulin requirement.

While pure fats such as butter and olive oil are the lowest on the insulin index, some carbohydrate-containing foods are lower on the insulin index than you’d expect simply from their carbohydrate content alone while lean protein foods such as steak and white fish cause high levels of insulin to be secreted even though they contain minimal carbohydrates.

Doctor Fung made the observation that the typical modern practice of having three meals plus snacks doesn’t give the body any time that there is not insulin circulating in our blood. In earlier times this wasn’t the case. There would have been periods of feasting in summer when carbohydrates eaten were stored via insulin as fat along with corresponding periods of famine and winter where insulin levels were low and fat stores could be used.

Constant elevated insulin levels lead to insulin resistance. The pancreas then produces more insulin to remove sugar from the blood. This compounds insulin resistance and leads to diabetes and obesity.

As well as high blood sugar, we have recently come to realise that high levels of insulin are also toxic.\(^3\) Even if you keep blood glucose levels low with insulin sensitising drugs and injected insulin, the level of inflammation and rate of complications from diabetes is still high.\(^4\)

By understanding what caused the problem we can do the opposite to treat the problem rather than simply taking drugs to mask the symptoms. Doctor Fung’s recommendation for addressing obesity is summarised in Table 1.

### Table 1 Factors that lead to and reverse diabetes

<table>
<thead>
<tr>
<th>Things that lead to diabetes</th>
<th>Thanks that reverse diabetes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excessive sugar and simple carbohydrates in the diet generate high insulin load</td>
<td>Reduce foods in your diet that require insulin(^5)</td>
</tr>
<tr>
<td>Constant food intake and high insulin levels</td>
<td>Periods of reduced insulin levels (e.g. intermittent fasting).</td>
</tr>
</tbody>
</table>

After watching Dr Fung’s videos and scouring through his extensive blog I was left wondering what we should be eating to minimise insulin load to optimise blood glucose control while maximising fibre and nutrition.

The journey to try to answer this question for myself and my family has been interesting.

I hope you’ll stick with me for the adventure which is detailed in the rest of this document.

#### 1.4 Food Insulin index

The initial research into the food insulin index is detailed in a 1997 paper by Susanne Holt et al who tested the insulin demand of thirty eight different foods.\(^6\)

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\(^2\) [https://www.youtube.com/user/drjasongfung](https://www.youtube.com/user/drjasongfung)


\(^4\) [https://www.youtube.com/watch?v=4oZ4UqtbB_g](https://www.youtube.com/watch?v=4oZ4UqtbB_g)

\(^5\) [http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2716748/](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2716748/)

\(^6\) [http://ajcn.nutrition.org/content/66/5/1264.short](http://ajcn.nutrition.org/content/66/5/1264.short)
The food insulin index data was determined by feeding 1000kJ (or 239 kcal) of a particular food to non-diabetics and measuring their insulin levels in response over three hours. Insulin secretion for a particular food was compared to the insulin secretion for white bread, which was assigned a value of 100%, to arrive at a value for each food.

Considering how potentially significant this data could be for “low carbers” trying to minimise the insulin effect of foods and for type 1 diabetics who have to calculate insulin doses for the food they eat I found it surprising that there hadn’t been much discussion of about it.

The initial testing in Table 2 shows that the foods lowest on the insulin index are generally high in fat. If we abandon the authority of the food pyramid and our fear of fat, the logical extension of this is that the ideal diet for diabetics or people wanting to lose weight by reducing insulin load would be to prioritise foods lowest on the insulin index such as butter, oils and bacon.

<table>
<thead>
<tr>
<th>Food</th>
<th>protein (g/MJ)</th>
<th>fat (g/MJ)</th>
<th>carb (g/MJ)</th>
<th>fibre (g/MJ)</th>
<th>Insulin index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butter</td>
<td>0</td>
<td>27</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Olive oil</td>
<td>0</td>
<td>27</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Bacon</td>
<td>16</td>
<td>19</td>
<td>1</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>Peanut butter</td>
<td>9</td>
<td>20</td>
<td>7</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Bologna</td>
<td>24</td>
<td>9</td>
<td>13</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>Peanuts</td>
<td>10</td>
<td>20</td>
<td>5</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>Tuna</td>
<td>24</td>
<td>15</td>
<td>2</td>
<td>0</td>
<td>16</td>
</tr>
</tbody>
</table>

Bob Briggs has a YouTube video “Butter Makes Your Pants Fall Off”7 with more than 100,000 views where he explains the mechanisms of controlling carbohydrates, how insulin promotes fat storage and how reducing carbohydrates and eating healthy fats leads to a reduction in appetite and can help people lose weight. The food insulin index explains why this is the case, with butter being the lowest of all foods measured on the insulin index.

The food insulin may partially explain the success of the Mediterranean diet which recommends liberal use of olive oil, which is also very low on the food insulin index.

It may be a stretch, but the food insulin index may be part of the reason why Rich Froning keeps winning the CrossFit Games and looking so ripped in spite of consuming an inordinate amount of peanut butter which is also low on the food insulin index.8

1.5 Latest food insulin index data

After more searching I came across a recent PhD thesis from the University Of Sydney titled Clinical Application of the Food Insulin Index to Diabetes Mellitus (Kristine Bell, September 2014).9

The thesis demonstrated that the food insulin index data had the following practical applications:

- calculating insulin dose based on the food insulin index data rather than carbohydrate counting provided better blood glucose control for type 1 diabetics, and

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7 [https://www.youtube.com/watch?v=h6aMN6NLOTQ](https://www.youtube.com/watch?v=h6aMN6NLOTQ)
9 [http://ses.library.usyd.edu.au/handle/2123/11945](http://ses.library.usyd.edu.au/handle/2123/11945)
• type 2 diabetics improved blood glucose control by choosing foods that caused a lower insulin secretion, independent of calories or carbohydrates.

Appendix 3 of the thesis contained an extensive database of foods that had now been tested. Figure 1 shows a plot of the carbohydrates versus the insulin index for the various foods tested.

![Figure 1: Carbs ingested versus insulin index (taken from Bell, 2014)](image)

The relationship between insulin demand and carbohydrate ingested is not straightforward. Of particular interest is the fact that there are a number of low carbohydrate, high protein and low fat foods sitting up high quite high up on the vertical axis.

The other limitation of this data is the list of foods is that we have to rely on the data limited range of foods that have been tested on healthy subjects.

1.6 Carbs, protein, type 1s and canaries

Quantification of insulin demand is of particular interest for type 1 diabetics who have to inject insulin to manage their blood glucose as well as their body fat to a large extent.

Before diagnosis, a type 1 diabetic whose pancreas is failing will have extremely high blood glucose levels and will be losing weight fast because they can’t access the sugar in their blood without insulin.

The body kicks into what some call a backup survival mechanism called ketosis in which it uses body fat for fuel rather than sugar from dietary carbohydrates. When combined with very high levels of glucose, this scenario is called diabetic ketoacidosis and can be a life threatening if left untreated.

After commencing insulin therapy a diabetic will regain weight. Sometimes more weight is gained than desired if additional carbohydrates are required to raise blood glucose driven low by excess

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insulin. Diabetics can even get localised fat deposits where around their insulin injection sites if they don’t rotate them and / or are taking large amounts of insulin.

Carbohydrates raise blood glucose and insulin works to remove the sugar from the blood to store as fat. In practice it’s impossible to perfectly match the insulin action with the rate of carbohydrate digestion.

While type 1 diabetics are an extreme case, I think type 1 diabetics can be considered to be the “canary in the coal mine” of weight maintenance and metabolic health. To some extent everyone’s body is working to balance the effect of carbohydrates and protein driving up blood glucose and with the pancreas secreting insulin to bring the blood glucose back down.

One thing that’s not well understood is how type 1 diabetics should deal with protein. Conventional wisdom is that type 1 diabetics should dose with about half the insulin for protein containing foods, however the basis of this is not clear.

With the food insulin index data now available perhaps we might be able to better understand the insulin requirements of protein containing foods?

1.7 Protein and the foods insulin index... Atkins versus the vegans

Dr Fung notes that the Atkins approach often doesn’t work over the long term because things other than carbohydrates stimulate insulin secretion.11

The irony of low carbers eating protein to avoid carbs to minimise insulin secretion although the insulin index data shows that protein foods cause a significant insulin effect has not been lost on the vegan community.12

In response to this, Gary Taubes has acknowledged that protein does stimulate insulin release, however “the assumption has always been that this effect is small compared to that of carbohydrates, and that it is muted because it takes considerably longer to digest protein from meat.”13

Is protein a significant issue an issue for people trying to control blood glucose and reduce the insulin load of their food? Perhaps the food insulin index data can help us find the answer.

11 http://intensivedietarymanagement.com/atkins-decline-hormonal-obesity-part-xx/
2  Analysis of food insulin index data

2.1  How much insulin is required to cover protein?

Given that protein appears to contribute to insulin demand I ran a number of scenarios with the food insulin index data to see if insulin requirement is better predicted by carbohydrate in a food plus some proportion of the protein.

The analysis indicated that insulin demand is related to carbohydrate plus about 60% of the protein.

Given that the food insulin index data is experimental I thought it safest to adopt the previously established value of 0.54 established by Wilder in the 1920s.\(^\text{14}\)

Figure 2 shows that the correlation of food insulin index with carbohydrate plus 0.54 time protein is better than carbohydrate alone (\(R^2 = 0.435\) compared to \(R^2 = 0.461\)). We no longer have the issue of high protein foods sitting on the vertical axis.

Accounting for protein in addition to carbohydrate allows better prediction of insulin demand. People wanting to reduce their insulin load could benefit by managing their protein intake as well as limiting carbohydrates.

![Figure 2 Carbohydrates + 0.54 x protein (g) versus food insulin index (%)](http://perfecthealthdiet.com/2011/02/ketogenic-diets-i-ways-to-make-a-diet-ketogenic/)

2.2  What about fibre... net carbs or total carbs?

Looking at the foods sitting above the trend line in Figure 2 it appears that the foods with the greatest insulin response compared to what would be predicted by carbohydrate and protein tend to be the ones that are more processed such as ice-cream, baked beans, pancakes and Jelly Beans. On the lower side of the trend line we tend to have less processed foods (e.g. full cream milk, navy beans, porridge and All Bran with added fibre).

Processed foods tend to contain less fibre, while carbohydrates in their original state typically contain more fibre. Fibre is indigestible carbohydrate and hence does not raise blood glucose or require insulin. Fibre is also important for our gut health and feeds the good bacteria in our digestive tract.15

Could we use fibre as a proxy for the level of processing to help refine the prediction of insulin demand by different foods?

In order to test whether fibre is useful to predict insulin demand I tested the relationship between carbohydrates plus different amounts of the fibre in the various foods. The best correlation was achieved by removing all of the fibre.

As shown in Figure 3, using net carbs gives an increased correlation compared to the carbohydrates alone (i.e. $R^2 = 0.435$ compared to $R^2 = 0.482$).

Considering the carbohydrates, protein and fibre in a food enables us to more accurately predict insulin demand.

**Figure 3 Net carbohydrates (g) versus food insulin index**

This concept is often referred to as “net carbs”. If you’re trying count carbohydrates to manage insulin people are often advised to consider the total carbohydrates minus the fibre16 as fibre cannot be digested but is rather digested by our intestinal bacteria.17

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16 This seems to work in practical application as well. We recently tried a low carb quesadilla recipe where the only carbohydrates used are psyllium husk to replace the flour in a normal recipe. My wife, who is a type 1 diabetic, dosed insulin for the total carbohydrates, without taking into account the fact that the psyllium is 100% fibre, and ended up with a low blood glucose due to excess insulin. In future with low carb meals it would be better to only dose with insulin for the net carbs, particularly for low carbohydrate meals.

17 One of the emerging areas is the realisation that fibre, which is carbohydrates that cannot be digested and used by the body, actually acts as food for healthy gut bacteria. One hypothesis is that fibre feeds the bacteria...
This aligns with the understanding that carbohydrates consumed with the packaging that they came with (i.e. fibre) do not have as big an effect on insulin. This relationship might be part of the reason why many populations have maintained good health on a higher level of carbohydrate consumed in their raw natural state compared to when they come from the supermarket in boxes with barcodes.

There is some disagreement out there on how to deal with fibre on a restricted carbohydrate approach:

- Some people say you should ignore fibre because “net carbs” is just a marketing ploy and that it is more “intellectually honest” to count all dietary fibre.
- Some people choose to count half the fibre as carbs as a middle ground.
- Experienced type 1 diabetics who monitor their blood glucose religiously using continuous glucose meters will tell you that the fibre in their veggies will not raise their blood glucose however they ignore the fibre in packaged foods because it does raise their blood sugar.

My interpretation of the food insulin index data is that real fibre in foods is indigestible and hence does not raise blood glucose and require insulin. However excess cooking and processing will likely soften this fibre and make it digestible.

Increasing the amount of fibre (e.g. by increasing your non-starchy veggies such as spinach, broccoli, mushrooms, Brussel sprouts and kale) will help to decrease your insulin load.

The big problem that I see with encouraging people to consider total carbohydrates is that it will mean that people will avoid vegetables which not be optimal for health in the long term.

2.3 How do you like your veggies... cooked or raw?

One consideration when it comes to veggies is the impact of cooking.

If you boil something to a mush then it’s probably not going to have the same quality of fibre as if you were to eat it in its raw unprocessed form. It’s also going to be easier to eat a lot more cooked veggies than raw veggies.

Table 3 shows a comparison of the fibre content of one hundred grams of cooked and raw vegetables sorted by the percentage of insulinogenic calories.

<table>
<thead>
<tr>
<th>food</th>
<th>raw</th>
<th>cooked</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>carbs</td>
<td>fibre</td>
<td>% insulinogenic</td>
<td>carbs</td>
</tr>
<tr>
<td>spinach</td>
<td>4</td>
<td>2</td>
<td>35%</td>
<td>4</td>
</tr>
<tr>
<td>broccoli</td>
<td>7</td>
<td>3</td>
<td>47%</td>
<td>7</td>
</tr>
<tr>
<td>eggplant</td>
<td>6</td>
<td>3</td>
<td>50%</td>
<td>8</td>
</tr>
<tr>
<td>artichoke (globe)</td>
<td>11</td>
<td>5</td>
<td>51%</td>
<td>12</td>
</tr>
<tr>
<td>mushroom</td>
<td>5</td>
<td>1</td>
<td>62%</td>
<td>5</td>
</tr>
<tr>
<td>carrots</td>
<td>10</td>
<td>3</td>
<td>68%</td>
<td>8</td>
</tr>
</tbody>
</table>

in the gut called bacteroides while sugars feed fermicutes and people with the highest bacteroides : fermicutes ratio tend to be leaner.
Spinach and broccoli when cooked don’t seem to lose a lot of their fibre through cooking. Eggplant seems to lose some fibre relative to carbohydrates and end up with an increased percentage of insulinogenic calories. Based on this data artichoke, mushroom and carrots to actually gain fibre relative to the overall level of carbohydrate, which is interesting.

Based on this you could eat 600g of spinach or 300g of broccoli and still have a Bernstein-compliant lunch of dinner (i.e. no more than 12g of carbs).

It’s also interesting to note that resistant starch is increased by cooking and cooling foods such as potato, rather than eating them in their raw or heated state.

Whatever the case, lightly steamed is probably your best bet to retain the nutrients and fibre in your veggies. If you want to check out how your favourite veggies fare before and after cooking you can find out at nutritiondata.self.com.

In view of the growing body of research showing that fibre is good for gut health which is in turn good for diabetes, insulin sensitivity and a whole host of other issues I think it’s hard to build a strong case for avoiding vegetables altogether just to minimise carbohydrates.

2.4 Putting it all together... protein and net carbs

So far we’ve learned that carbohydrate isn’t a fantastic predictor of insulin requirement by itself.

The observation that protein requires about half as much insulin as carbohydrate improves our estimation of insulin demand.

Then understanding that fibre neutralises the insulin effect of carbohydrates the indigestible fibre helps us better the amount the amount of insulin required by a particular food.

If we combine the concept of net carbs with protein being insulinogenic we get the plot shown in Figure 4 which has an even better correlation ($R^2 = 0.505$).

**Figure 4** Net carbs plus $0.54 \times$ protein versus food insulin index
Using net carbohydrates with an allowance for about half the protein gives us a better way to estimate insulin requirement of food compared to using carbohydrates alone.

This understanding could be very useful for type 1 diabetics wanting to calculate their insulin dose as well as for people wanting to manage their insulin levels by informing their food selection.

2.5 How long does protein take to digest?

One of the many challenges for type 1 diabetics is that, even if they limit their carbohydrate intake, their blood glucose will often spike a number of hours after a high protein meal. The benefit of protein however is that it does not typically spike blood glucose as much as or as quickly as carbohydrate and is therefore easier to manage and control blood glucose.

As shown in Figure 5, simple carbohydrates cause blood glucose to rise and fall quickly, however protein causes a rise in blood glucose between four and six hours after a meal.

![Figure 5 blood glucose reaction for various food versus time](http://www.dietdoctor.com/the-dreamfields-pasta-fraud)

One of the potential limitations of the food insulin index data is that the tests were undertaken over a period of three hours. However protein takes a lot longer than this to fully digest. This could mean that protein actually has an even greater impact on insulin and blood glucose than indicated by this data.

2.6 Is the insulin reaction to protein dose dependent?

The observation that protein requires insulin initially appears to conflict with a number of studies and anecdotal evidence that indicate that protein does not have a significant effect on blood sugar.

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19 [http://ses.library.usyd.edu.au/handle/2123/11945](http://ses.library.usyd.edu.au/handle/2123/11945)
Firstly, a healthy non-diabetic will typically be able to deal with the blood glucose rise caused by gluconeogenesis due to protein, hence the overall blood glucose rise may not be significant. Type 1 diabetics however certainly do see a rise in their blood glucose levels that they need to “cover” with insulin between three and five hours after eating.

If you’re metabolically healthy then the blood glucose rise and insulin secretion due to gluconeogenesis after a large protein meal may not be cause for concern. However if you are not metabolically healthy or want to achieve higher levels of ketosis and/or reduce your blood glucose levels then moderating protein to manage excessive gluconeogenesis and increasing the fat and/or fibre in your diet may be something you might want to do.

Secondly, the degree of gluconeogenesis appears to be dose dependent. If you are exercising intensely and your protein load is moderate then your body will likely shuttle the protein ingested to your muscles for growth and repair as the highest priority. On the other hand, if you have not been active, and you eat a large amount of protein then the excess protein will be converted to glucose in your blood stream, raise insulin levels and eventually be sorted as fat.

The effect of protein on your blood glucose will be variable. However allowing for about half the insulinogenic effect of carbohydrates appears to be a good start if we are calculating insulin dosages or identifying the most ketogenic diet foods.

2.7 Is sugar really toxic?

You may have noticed that there are a lot of people quitting sugar\(^23\) or declaring that it is toxic\(^24\).

But what does the food insulin index data have to say about sugar? Is it any different to other forms of carbohydrate?

I ran a similar analysis to the process described above to see if sugar had a unique effect on insulin compared to non-sugar carbohydrate which indicated that sugar does not generate more insulin than other forms of carbohydrates. If anything, sugar requires slightly less insulin on a gram for gram basis compared to carbohydrates (say about 90%).

This could be because sugar is metabolised quickly and the body pushes out a short burst of insulin to clear the sugar from the blood rather than the long persistent effort that might occur with a lower glycemic index carbohydrate.

This is not to say that sugar is good for you. You should keep in mind that:

1. Refined carbohydrates have no fibre and are very calorie dense. You can eat a lot without feeling full.
2. Refined sugar has a very low nutrient density. Your body is left searching for adequate nutrition and will be prone to over consume calories.
3. Sugar will cause your blood glucose to rise quickly. Your body will produce a burst of insulin which will cause your blood glucose to crash after the insulin surge and leave you feeling hungry again, craving more sugar.

\(^{23}\) https://iquitsugar.com/
\(^{24}\) https://www.youtube.com/watch?v=dBnniu6-oM
By contrast, the carbohydrates in non-starchy veggies (e.g. spinach, kale, avocado, and asparagus) come packaged with fibre, digest slowly and will leave you feeling full, raise your blood glucose gently and are very hard to overeat.  

2.8 Glycemic load versus insulin load

Glycemic index (GI) measures the rise in blood glucose in healthy people in response to the ingestion of various foods. The theory goes that it is better to eat low glycemic index carbohydrates that will not raise our blood glucose too much to prioritise foods that will take longer to digest.

Building on the glycemic index (GI) is the concept of glycemic load. The glycemic load of a food is the GI of a food multiplied by the grams of carbohydrate eaten.

For instance, watermelon has a very high GI value, however because watermelon only contains a small quantity of carbohydrates (it’s mostly water) the overall glycemic load is small. By contrast, a high glycemic load occurs when you eat a large quantity of a high glycemic index carbohydrate, such as a bread roll.

The limitation of the GI approach is that we can eat a still eat a diet of full of low glycemic index carbohydrates and proteins that still require a significant amount of insulin, even though our blood sugar isn’t rising significantly. Even though they are slow to digest and do not raise blood glucose as much, they still require substantial amounts of insulin. Maintaining reasonable blood glucose in spite of a moderate glycaemic load is just an indication that you pancreas is keeping up, for now.

Various studies have shown that eating a low GI diet doesn’t lead to weight loss. We also now know that high insulin levels are a greater health risk than high blood glucose. Rather than focusing on the glycemic load or the glycemic index which just considers the symptom of higher blood sugars, I believe it would be better to focus on the core of the problem by managing the insulin load of the diet, particularly if achieving optimal blood glucose or reducing excess body fat is an issue for you.

2.9 Is dairy and red meat more insulinogenic?

The original 1997 paper by Susan Holt et al looking at the food insulin index suggested that dairy and meat proteins may be more insulinogenic than vegetable proteins. You may have also heard it said in health circles that dairy products have some special hormonal property that requires more insulin than other foods.

In order to test whether particular groups of foods might have some unique insulinogenic properties I have plotted the insulin reaction for various types of proteins separately.

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25 I’m not going to deliver into the fructose / glucose issue. If you want to go there check out https://www.youtube.com/watch?v=dBnniu6-oM or the condensed Shaun Croxton version at https://www.youtube.com/watch?v=tdMjKEncojQ
26 http://www.glycemicindex.com/
30 http://chriskresser.com/is-the-glycemic-index-useful
32 http://ajcn.nutrition.org/content/66/5/1264.abstract
33 http://www.marksdailyapple.com/dairy-insulin/
Figure 6 shows that fish (based on only four data points) and dairy (based on thirteen data points) seem to have the greatest insulin reaction while vegetables and animal protein have the lowest insulin response.

![Comparison of insulin reaction to different types of protein](image)

**Figure 6  Comparison of insulin reaction to different types of protein**

However if we account for the indigestible fibre (i.e. net carbs) then legumes (based on only five data points) appear to require more insulin while fruit and vegetables require less insulin as shown in Figure 7.
Figure 7 Comparison of insulin reaction to different types of protein - net carbs

My interpretation of this is that there is currently not adequate data to demonstrate that insulin response of a food is influenced significantly by anything other than carbohydrates, fibre and protein.

It could be possible that this understanding could be refined with more testing in the future, however the impact in addition to considering carbohydrates, protein and fibre are likely to not be statistically significant.

2.10 Can you eat too much fat on a low carb diet?

Even though Wilder’s formula\(^{34}\) allows 10% for fat being anti-ketogenic, the insulin index data does not indicate that there is any effect on insulin from fat. The best correlation with the food insulin index was achieved with zero times fat. This is aligns with the observation of type 1 diabetics who can eat fat without raising their blood glucose or requiring insulin.

Eating a controlled carbohydrate, high fibre, moderate protein diet will typically lead to increased satiety and a reduction in calorie intake. Reducing insulin will allow stored body fat to be used for fuel. If someone was trying to lose weight I would not recommend emphasising too much added dietary fat once they were fat adapted so they could allow the fat come from the body.

Some people aiming for ketosis to lose weight can overdo the fat calories and not achieve their desired weight loss. If your aim is weight loss it’s better to be in a calorie deficit and be burning stored body fat than have high blood ketone values because you’re burning fat from MCT oil and butter.

\(^{34}\) [http://perfecthealthdiet.com/2011/02/ketogenic-diets-i-ways-to-make-a-diet-ketogenic/]
While counting calories may be beneficial for some people in the short term to retrain their appetite, a better approach may be to try extending the periods between meals (i.e. intermittent fasting) to reset your insulin sensitivity and reduce overall calorie intake.

2.11 Proportion of insulinogenic calories

Someone looking to reduce the carbohydrates in their diet will typically try to limit the number of carbohydrates per serving shown on the nutritional label.

This approach has limited benefit as the food may or may not contain a lot of water which makes it hard to compare in terms of carbohydrates per calorie.

Another way is to look at the amount of protein and fat in relation to the carbohydrates, but again this is a difficult calculation to make when you’re looking at the nutritional label in the shopping isle.

If we take the concept of “net carbs” and the idea that protein has some insulinogenic effect we can calculate the proportion of insulinogenic calories using the following formula:

\[
\% \text{ insulinogenic calories} = \frac{[\text{carbohydrates} - \text{fibre} + 0.54 \times \text{protein}]}{\text{total calories}} \times 4 \text{ cal/g}
\]

This calculation could be useful to determine whether one food is better than another if you’re trying to minimise your insulin load. The lower the proportion of insulinogenic calories in your food the less likely your meal is going to require large amounts of insulin, raise your blood glucose or cause you to store fat.

Sure, this is not a simple calculation we can quickly do in the shopping isle either. However using readily available nutritional data we can compare and rank a wide range of foods, making us better informed when we prepare our shopping list.
3 The most ketogenic foods

3.1 General

This section looks at the proportion of insulinogenic calories for various food groups to help us understand which foods might be better than others. These calculations are based on the USDA foods database which contains nearly 8000 foods.35

I have tried to simplify and consolidate this data to arrive at a manageable list of foods in each section.

If you want to play with the data yourself it can be downloaded from the files section at facebook.com/groups/optimisingnutrition/

3.2 Least insulinogenic foods

As you might expect, the foods with the lowest insulinogenic percentage are the fats and oils that don’t contain any carbohydrate or protein such as butter, coconut oil, olive oil, butter, flax seed oil and lard.

If we drop out the foods that are primarily fats and oils and sort by the proportion of insulinogenic calories we end up with a list of decadent full fat foods shown in Table 4.

Table 4 Least insulinogenic foods – excluding fats and oils

<table>
<thead>
<tr>
<th>Food</th>
<th>% insulinogenic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sesame seeds</td>
<td>2%</td>
</tr>
<tr>
<td>Olives</td>
<td>2%</td>
</tr>
<tr>
<td>Beef sausage</td>
<td>2%</td>
</tr>
<tr>
<td>Bratwurst</td>
<td>2%</td>
</tr>
<tr>
<td>Pecans</td>
<td>2%</td>
</tr>
<tr>
<td>Pepperoni</td>
<td>3%</td>
</tr>
<tr>
<td>Flaxseed</td>
<td>3%</td>
</tr>
<tr>
<td>Frankfurter</td>
<td>3%</td>
</tr>
<tr>
<td>Macadamia nuts</td>
<td>3%</td>
</tr>
<tr>
<td>Duck</td>
<td>3%</td>
</tr>
<tr>
<td>Pork sausage</td>
<td>3%</td>
</tr>
<tr>
<td>Mackerel</td>
<td>3%</td>
</tr>
<tr>
<td>Sausage</td>
<td>3%</td>
</tr>
<tr>
<td>Cream</td>
<td>3%</td>
</tr>
<tr>
<td>Bacon</td>
<td>4%</td>
</tr>
</tbody>
</table>

3.3 Most insulinogenic foods

If we take this ranking system to the other extreme and sort for the most insulinogenic foods we get the list of high sugar foods shown in Table 5. Everyone these days seems to agree that you should avoid these sorts of “foods” with high levels of sugar. Hence this approach to ranking foods based on their proportion of insulinogenic calories seems to make sense.

Table 5 Most insulinogenic foods

<table>
<thead>
<tr>
<th>Food</th>
<th>% insulinogenic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molasses</td>
<td>100%</td>
</tr>
<tr>
<td>Maple syrup</td>
<td>100%</td>
</tr>
<tr>
<td>Cranberry juice</td>
<td>100%</td>
</tr>
</tbody>
</table>

35 http://www.ars.usda.gov/Services/docs.htm?docid=24912
3.4 Eggs

Eggs are a staple for low carbers, keto dieters and diabetics. Not only are they highly nutritious they are also low in carbohydrates and moderate in protein.

Eggs do contain some protein which requires insulin. Eating the whole egg or even the egg yolk (rather than white alone which is mainly protein) is a good option if you’re trying to optimise your blood sugars.

<table>
<thead>
<tr>
<th>Food</th>
<th>% insulinogenic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar</td>
<td>100%</td>
</tr>
<tr>
<td>Grape juice drink</td>
<td>100%</td>
</tr>
<tr>
<td>Cranberry juice</td>
<td>100%</td>
</tr>
<tr>
<td>Mango nectar</td>
<td>100%</td>
</tr>
<tr>
<td>Apricot nectar</td>
<td>100%</td>
</tr>
<tr>
<td>Peach nectar</td>
<td>100%</td>
</tr>
<tr>
<td>Watermelon</td>
<td>100%</td>
</tr>
<tr>
<td>Honey</td>
<td>100%</td>
</tr>
<tr>
<td>Marmalade, orange</td>
<td>99%</td>
</tr>
<tr>
<td>Jellies</td>
<td>98%</td>
</tr>
<tr>
<td>jams and preserves</td>
<td>98%</td>
</tr>
</tbody>
</table>

As a reference point, I suggest you keep in mind the fact that eggs have a proportion of insulinogenic calories of about 20% as you scan through the other food groups below.

3.5 Dairy products

3.5.1 General

While cheese and cream are often favoured by people trying to restrict carbohydrates, many people say that they have more success with their weight loss if they limit dairy.

But should we avoid all dairy? Is some dairy better than others on a ketogenic diet?

Rather than simply dismiss all dairy, it may be more useful to think of various dairy products in terms of the proportion of insulinogenic calories for each food.

3.5.2 Cheese

The calculated proportion of insulinogenic calories for various cheese products is shown in Table 7.

Higher fat cheeses such as brie, limburger, camembert, cheddar, and cream cheese require little insulin. On the other end of the scale is pretty much anything that is low fat or skim. It appears that cheese can be part of a ketogenic diet if we choose the higher fat, lower protein options.

<table>
<thead>
<tr>
<th>Cheese</th>
<th>% insulinogenic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brie</td>
<td>4%</td>
</tr>
<tr>
<td>Limburger</td>
<td>4%</td>
</tr>
<tr>
<td>Camembert</td>
<td>4%</td>
</tr>
</tbody>
</table>

Table 6 Insulinogenic percentage – eggs

<table>
<thead>
<tr>
<th>food</th>
<th>% protein</th>
<th>% carbs</th>
<th>% insulinogenic</th>
</tr>
</thead>
<tbody>
<tr>
<td>egg yolk</td>
<td>20%</td>
<td>4%</td>
<td>15%</td>
</tr>
<tr>
<td>whole egg</td>
<td>35%</td>
<td>2%</td>
<td>21%</td>
</tr>
<tr>
<td>egg white</td>
<td>84%</td>
<td>6%</td>
<td>51%</td>
</tr>
</tbody>
</table>

As a reference point, I suggest you keep in mind the fact that eggs have a proportion of insulinogenic calories of about 20% as you scan through the other food groups below.
Cheese % insulinogenic
Gruyere 4%
Monterey 4%
Cheddar 5%
Edam 5%
Cream 6%
Colby 6%
Blue 6%
Gouda 6%
Mozzarella 7%
Parmesan 9%
Feta 9%
Swiss 10%
Mozzarella, skim milk 10%
Ricotta, whole milk 10%
Low fat, cheddar or Colby 12%
Swiss, low fat 17%
Mozzarella, non-fat 17%
Cream, low fat 18%
Ricotta, part skim milk 19%
Cottage cheese, low fat 28%
Cream, fat free 38%

3.5.3 Milk

Table 8 shows the insulinogenic percentage for various types of milk.

Milk requires a lot more insulin than the high fat cheeses due to their carbohydrate and protein content. If you are going to drink milk, keep it to a minimum if you’re struggling to optimise your blood sugars, and choose full fat milk, not skim.

The other issue with dairy is that it is typically very calorie dense, meaning that it is easy to consume a lot of energy calories quickly. This is great if you’re a growing baby, an athlete trying to replenish energy or a body builder trying to spike insulin for muscle growth. However moderate insulin load and high palatability are not a good combination if you’re trying to lose weight.

Table 8 Insulinogenic percentage – milk
Milk % insulinogenic
Full cream milk, 3.7% fat 32%
Human milk 40%
Skim milk, 1% fat 52%
Chocolate milk, low fat 65%

3.5.4 Yogurt

Table 9 shows the percentage of insulinogenic calories for various yogurts.

Again, the full fat plain yogurts have the lowest proportion of insulinogenic calories while the sweetened and low fat options are extremely insulinogenic and should be avoided. Even Greek yogurt is borderline due to the high protein content, with a significantly higher proportion of insulinogenic calories than eggs.

Table 9 Insulinogenic percentage – yogurt
Yogurt % insulinogenic
Full fat Greek yogurt 33%
3.6 Fruits

It’s interesting to note that there are only a handful of fruits that rank well in terms of their proportion of insulinogenic calories - olives and avocados. Once beyond olives and avocados the insulinogenic ratio shoots right up as shown in Table 10. If you’re trying to reduce your insulin load and optimise your blood sugars then generally fruits aren’t your friend.

**Table 10 Insulinogenic percentage – fruits**

<table>
<thead>
<tr>
<th>Fruit</th>
<th>% insulinogenic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olives</td>
<td>2%</td>
</tr>
<tr>
<td>Avocados</td>
<td>5%</td>
</tr>
<tr>
<td>Blackberries</td>
<td>37%</td>
</tr>
<tr>
<td>Raspberries</td>
<td>38%</td>
</tr>
<tr>
<td>Gooseberries</td>
<td>49%</td>
</tr>
<tr>
<td>Rhubarb, raw</td>
<td>49%</td>
</tr>
</tbody>
</table>

3.7 Vegetables

Vegetables have a low to moderate proportion of insulinogenic calories. Once we consider the fibre content, all of the vegetable shown Table 11 have a lower percentage of insulinogenic calories than whole eggs. We can use the most nutrient dense of these to make sure we are obtaining adequate vitamin and mineral. It’s hard to overeat non-starchy veggies as they have a very low calorie density and are very filling.

**Table 11 Insulinogenic percentage – vegetables**

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>% insulinogenic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chrysanthemum</td>
<td>6%</td>
</tr>
<tr>
<td>Broccoli</td>
<td>8%</td>
</tr>
<tr>
<td>Dock</td>
<td>8%</td>
</tr>
<tr>
<td>Endive</td>
<td>8%</td>
</tr>
<tr>
<td>Mustard greens</td>
<td>8%</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>10%</td>
</tr>
<tr>
<td>Asparagus</td>
<td>12%</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>13%</td>
</tr>
<tr>
<td>Chicory greens</td>
<td>13%</td>
</tr>
<tr>
<td>Peppers, red</td>
<td>14%</td>
</tr>
<tr>
<td>Spinach</td>
<td>15%</td>
</tr>
<tr>
<td>Parsley</td>
<td>16%</td>
</tr>
<tr>
<td>Coriander</td>
<td>17%</td>
</tr>
<tr>
<td>Turnip</td>
<td>17%</td>
</tr>
<tr>
<td>Onions</td>
<td>19%</td>
</tr>
<tr>
<td>Bamboo shoots</td>
<td>20%</td>
</tr>
<tr>
<td>Spinach</td>
<td>20%</td>
</tr>
<tr>
<td>Artichokes</td>
<td>21%</td>
</tr>
<tr>
<td>Chinese cabbage</td>
<td>21%</td>
</tr>
</tbody>
</table>
3.8 Nuts and Seeds

Table 12 shows that most of the nuts and seeds have a low proportion of insulinogenic calories, with macadamias, pecans, flax seeds, Brazil nuts, walnuts and coconut landing at the top of the list. However unlike non-starchy veggies, it’s easy to eat too many nuts and overdo the calories.

It’s also worth noting that coconut milk and coconut cream, which have a low insulinogenic percentage, can be used as milk alternatives in your coffee. Also included are peanuts which are a legume they are cheap, nutrient dense and reasonably good when it comes to the proportion of insulinogenic calories.

Table 12 Insulinogenic percentage – nuts, seeds and legumes

<table>
<thead>
<tr>
<th>Nuts, seeds legumes</th>
<th>% insulinogenic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macadamia</td>
<td>3%</td>
</tr>
<tr>
<td>Pecans</td>
<td>3%</td>
</tr>
<tr>
<td>Flaxseed</td>
<td>3%</td>
</tr>
<tr>
<td>Brazil nuts</td>
<td>4%</td>
</tr>
<tr>
<td>Walnuts</td>
<td>4%</td>
</tr>
<tr>
<td>Coconut meat</td>
<td>5%</td>
</tr>
<tr>
<td>Coconut cream</td>
<td>6%</td>
</tr>
<tr>
<td>Coconut milk</td>
<td>6%</td>
</tr>
<tr>
<td>Pine nuts</td>
<td>6%</td>
</tr>
<tr>
<td>Pumpkin seeds</td>
<td>6%</td>
</tr>
<tr>
<td>Peanuts</td>
<td>7%</td>
</tr>
<tr>
<td>Almond butter</td>
<td>7%</td>
</tr>
<tr>
<td>Almonds</td>
<td>7%</td>
</tr>
<tr>
<td>Chia seeds</td>
<td>8%</td>
</tr>
<tr>
<td>Sesame seeds</td>
<td>8%</td>
</tr>
<tr>
<td>Sunflower seeds</td>
<td>9%</td>
</tr>
<tr>
<td>Pistachio nuts</td>
<td>13%</td>
</tr>
<tr>
<td>Sesame butter</td>
<td>13%</td>
</tr>
<tr>
<td>Cashew butter</td>
<td>18%</td>
</tr>
</tbody>
</table>

3.9 Fish

Table 13 shows that the proportion of insulinogenic calories for fish ranges from 3% to 30% insulinogenic calories. If you can, stick to the fattier deep sea fish at the top of the list. Fish is also a great source of Omega 3 / DHA which are very important.

Table 13 Insulinogenic percentage – fish

<table>
<thead>
<tr>
<th>Food</th>
<th>% insulinogenic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mackerel</td>
<td>3%</td>
</tr>
<tr>
<td>Halibut</td>
<td>4%</td>
</tr>
<tr>
<td>Herring</td>
<td>5%</td>
</tr>
<tr>
<td>Salmon</td>
<td>6%</td>
</tr>
<tr>
<td>Sardine</td>
<td>7%</td>
</tr>
<tr>
<td>Anchovy</td>
<td>8%</td>
</tr>
<tr>
<td>Carp</td>
<td>8%</td>
</tr>
<tr>
<td>Swordfish</td>
<td>8%</td>
</tr>
<tr>
<td>Trout</td>
<td>8%</td>
</tr>
<tr>
<td>Tuna</td>
<td>8%</td>
</tr>
<tr>
<td>Whitefish</td>
<td>8%</td>
</tr>
<tr>
<td>Bass</td>
<td>9%</td>
</tr>
<tr>
<td>Crab</td>
<td>9%</td>
</tr>
<tr>
<td>Mullet</td>
<td>9%</td>
</tr>
</tbody>
</table>
### Food % insulinogenic

<table>
<thead>
<tr>
<th>Food</th>
<th>% insulinogenic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellowtail</td>
<td>9%</td>
</tr>
<tr>
<td>Monkfish</td>
<td>11%</td>
</tr>
<tr>
<td>Perch</td>
<td>11%</td>
</tr>
<tr>
<td>Sea bass</td>
<td>11%</td>
</tr>
<tr>
<td>Haddock</td>
<td>12%</td>
</tr>
<tr>
<td>Pollock</td>
<td>12%</td>
</tr>
<tr>
<td>Shrimp</td>
<td>12%</td>
</tr>
<tr>
<td>Snapper</td>
<td>12%</td>
</tr>
<tr>
<td>Ling</td>
<td>13%</td>
</tr>
<tr>
<td>Octopus</td>
<td>22%</td>
</tr>
<tr>
<td>Squid</td>
<td>24%</td>
</tr>
<tr>
<td>Mussel</td>
<td>26%</td>
</tr>
<tr>
<td>Clam</td>
<td>27%</td>
</tr>
<tr>
<td>Oyster</td>
<td>29%</td>
</tr>
<tr>
<td>Scallop</td>
<td>29%</td>
</tr>
<tr>
<td>Abalone</td>
<td>30%</td>
</tr>
</tbody>
</table>

### 3.10 Meat

Table 14 shows that the insulinogenic percentage for meats are generally low, with fatty sausage and fattier cuts of meat being less insulinogenic.

**Table 14 Insulinogenic calories - lamb and beef and poultry**

<table>
<thead>
<tr>
<th>Food</th>
<th>% insulinogenic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duck (with skin)</td>
<td>3%</td>
</tr>
<tr>
<td>Beef</td>
<td>4%</td>
</tr>
<tr>
<td>Lamb mince</td>
<td>5%</td>
</tr>
<tr>
<td>Pork, bacon</td>
<td>5%</td>
</tr>
<tr>
<td>Chicken</td>
<td>5%</td>
</tr>
<tr>
<td>Foie gras (goose liver pate)</td>
<td>5%</td>
</tr>
<tr>
<td>Pork, blade, hocks &amp; shoulder</td>
<td>6%</td>
</tr>
<tr>
<td>Quail</td>
<td>6%</td>
</tr>
<tr>
<td>Turkey</td>
<td>6%</td>
</tr>
<tr>
<td>Lamb chops</td>
<td>7%</td>
</tr>
<tr>
<td>Veal</td>
<td>8%</td>
</tr>
<tr>
<td>Pork, ham</td>
<td>8%</td>
</tr>
</tbody>
</table>

### 3.11 Total carbs, net carbs and insulin load

Equipped with the understanding that insulin demand is proportional to the carbohydrates, protein and fibre in food we can compare various dietary approaches based on their relative insulin load. Table 15 shows a comparison of total carbs, net carbs and insulin load across a range of dietary regimes for an intake of 2000 calories per day.

**Table 15 Comparison of theoretical insulin calculations for different dietary approaches**

<table>
<thead>
<tr>
<th>dietary approach</th>
<th>carbs %</th>
<th>protein %</th>
<th>fat %</th>
<th>fibre (g)</th>
<th>carbs (g)</th>
<th>net carbs (g)</th>
<th>insulin load (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>fruitarian</td>
<td>91%</td>
<td>3%</td>
<td>6%</td>
<td>54</td>
<td>455</td>
<td>401</td>
<td>409</td>
</tr>
<tr>
<td>grains on a budget</td>
<td>62%</td>
<td>14%</td>
<td>24%</td>
<td>25</td>
<td>310</td>
<td>285</td>
<td>323</td>
</tr>
<tr>
<td>high fibre vegetarian</td>
<td>70%</td>
<td>23%</td>
<td>7%</td>
<td>143</td>
<td>350</td>
<td>207</td>
<td>269</td>
</tr>
<tr>
<td>Mediterranean</td>
<td>45%</td>
<td>21%</td>
<td>34%</td>
<td>34</td>
<td>225</td>
<td>191</td>
<td>248</td>
</tr>
<tr>
<td>Zone diet</td>
<td>40%</td>
<td>30%</td>
<td>30%</td>
<td>44</td>
<td>200</td>
<td>156</td>
<td>237</td>
</tr>
<tr>
<td>high veggies</td>
<td>17%</td>
<td>28%</td>
<td>55%</td>
<td>24</td>
<td>85</td>
<td>61</td>
<td>137</td>
</tr>
<tr>
<td>high fat, low carb</td>
<td>3%</td>
<td>10%</td>
<td>87%</td>
<td>6</td>
<td>15</td>
<td>9</td>
<td>36</td>
</tr>
</tbody>
</table>
Calculation of insulin load is similar to carbohydrate counting, but with the addition of consideration of the fibre and protein in a food.

\[ \text{insulin load (g)} = \text{carbohydrates (g)} - \text{fibre (g)} + 0.54 \times \text{protein (g)} \]

For high carbohydrate diets, consideration of protein and fibre doesn’t make a significant difference. The total carbs, net carbs and the insulin load are all about the same. However for diets lower in carbohydrates consideration of the protein and fibre content can make a significant difference to the calculated insulin dose.

The effect on insulin requirement of protein and fibre becomes particularly important for type 1 diabetics running on restricted carbohydrate, higher protein diets.

A better understanding of the insulin load of a diet may be useful for diabetics wanting to normalise their blood glucose as much as possible or for people wanting to achieve nutritional ketosis.

3.12 Application of insulin load for type 1 diabetics

Experienced type 1 diabetics know that they need to cover protein as well as carbohydrates with insulin to prevent high blood glucose.

Type 1 diabetics with a continuous glucose meter will typically dose for carbohydrates with the meal and then watch for a blood glucose rise due to the protein and dose with extra insulin to correct. This may require a number of micro doses to keep blood glucose within the target range (typically 70 to 100mg/dL or 3.9 to 5.6mmol/L).

One of the experiments documented in *Clinical Application of the Food Insulin Index to Diabetes Mellitus* (Bell, 2014) demonstrated that type 1 diabetics calculating their insulin doses based on the food insulin index test data achieved significantly improved blood glucose control compared with those using standard carbohydrate counting.

The limitation of using the food insulin index data is that the food selection is limited to the one hundred or so foods that had already been tested and these are typically processed supermarket foods. However using our understanding of the insulinogenic effect of carbohydrates, protein and fibre we can calculate insulin requirements for any food.

This type of approach has been around for some, though not widely used. The TAG (Total Available Glucose) approach is based on a book by Mary Joan Oexmann published in 1989. There is a massive discussion on TAG and dual wave bolus on the TuDiabetes forum that is very informative.

Once basal rates are refined, type 1s using this approach were able to achieve much less volatility in their blood glucose. If you find that are going low using this approach check your basal patterns to make sure you’re not already covering for protein in your basal and / or look at modifying your carb / insulin ratio.

If we gave all the insulin calculated for the carbohydrates and the protein when we sat down to eat a high protein meal it’s likely that the insulin would take effect before the protein digested, leading to a low blood glucose before the gluconeogenesis from the protein had time to kick in. To overcome this, the insulin is typically given as a ‘dual wave boluses. That is, the insulin for the carbohydrates is

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36 [http://ses.library.usyd.edu.au/handle/2123/11945](http://ses.library.usyd.edu.au/handle/2123/11945)
38 [http://www.tudiabetes.org/forum/topics/dual-wave-bolus](http://www.tudiabetes.org/forum/topics/dual-wave-bolus)
dosed with the meal while the insulin for the protein is infused slowly as a separate “square wave bolus” over a period of three hours or so.

I have incorporated the insulin load and percentage carbohydrates calculations into the meal ranking – type 1 spreadsheet. Someone wanting to use this approach could do the following:

1. Set your insulin pump to give a dual wave bolus.
2. Program the pump to dose based on the number of grams shown for that meal in the “insulin load” column.
3. Program your pump with the “% carb insulin”. This number tells the pump how much to give with the meal versus over an extended period to cover the slower digesting protein.
4. Check your blood glucose at around two hours after the meal to see if you have adequate insulin on board and adjust accordingly.

This approach also allows refinements to be made while the dosing for protein is underway which is more forgiving than injecting all the insulin for a meal up front.

3.13 Summary
The highest priority for diabetics is to reduce their carbohydrates to reduce the amplitude of their blood glucose swings.

Once carbohydrates have been reduced it may be useful to consider the effect of protein and fibre by prioritising foods with the lowest proportion of insulinogenic calories.

Analysis of the food insulin index data confirms that protein requires about half the insulin compared to carbohydrates.

Insulin demand can be reduced by reducing net carbohydrates and maximising fibre (i.e. indigestible carbohydrate).

While consideration of protein and fibre will not make a big difference for someone on a high carb diet, it is an important consideration for someone on a restricted carbohydrate diet looking to achieve excellent blood glucose control.

For a type 1 diabetic consideration of the insulin load (i.e. considering the effect of protein and fibre) will enable them to fine tune their insulin dosage to optimise blood glucose control. A type 2 diabetic wanting to normalise their blood glucose would also benefit from eating a diet with a low low insulin load.

The meal ranking spreadsheet helps people choose nutritious low insulin load meals. For type 1 diabetics this spreadsheet also calculates the total insulin load and the split between the carb bolus to be given up front and the insulin for protein which can be given as a square wave bolus.
4 Diet wars... which one is best

4.1 Do we really need carbs?

Current mainstream dietary guidelines recommend that we get 45 to 65% of calories from carbohydrates. In line with these recommendations carbohydrate intake has increased progressively (as shown in Figure 8) as people have endeavoured to minimise fats.

![Figure 8 Change in macronutrient consumption over time](http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5304a3.htm)

However researchers in the area of nutrition are coming out and saying that health authorities got it wrong about fats and that our fear of fat has led us to the consumption of more carbs which has caused to the current obesity epidemic.

There are essential fats that the body cannot produce, such as alpha-linoleic acid and linoleic acid, which we need to obtain from our diet. The body also needs protein which forms the building blocks for the cells which it can’t make from other foods. The body can however produce glucose from protein via gluconeogenesis.

Consequently, often asked (and debated) questions are:

- If there is no such thing as an essential carbohydrate why do we need to be eating any carbohydrates?
- If we took food insulin theory to its logical extreme, could or should we live off just fat and “adequate” protein?
- How low (carb) can we go while still getting adequate nutrition?

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40 [http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5304a3.htm](http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5304a3.htm)
4.2 The great carbohydrate debate

4.2.1 Low carbohydrate ketogenic extreme

On the low carbohydrate end of this debate you have people like Dr David Perlmutter, Nora Gedgaudas, Ron Rosedale and Dr William Davis arguing that you should restrict carbohydrate for metabolic and brain health as well as the prevention and cure of a range of diseases.

Figure 9 shows one of the more confronting charts from Dr Perlmutter’s Grain Brain showing that the rate of brain shrinkage with age increases dramatically once we get an HbA1c of more than 5.2%.

![A1c Graph](image)

**Figure 9 HbA1c versus annual rate of brain shrinkage**

Figure 10 shows that an increase in HbA1c is correlated with an increased risk of cancer, particularly once we get an HbA1c over about 6% (i.e. average blood glucose of 7.0mmol/L or 126mg/dL).

![HbA1c Cancer Graph](image)

**Figure 10 HbA1c (%) versus hazard ratio for cancer**

Figure 11 shows that the risk for cardiovascular disease, coronary heart disease and stroke all increase once we get an HbA1c greater than 5.0% and especially over 5.4%. It’s also worth noting

44 [http://www.drperlmutter.com/important-blood-test/](http://www.drperlmutter.com/important-blood-test/)
that being on antidiabetic medication, even if it reduces your blood glucose, doesn’t help reduce your risk of heart disease.

Figure 11 HbA1c versus risk of cardiovascular diseases

Perhaps keeping your blood glucose under control is the most important thing you can do to manage your health and slow the aging process, regardless of whether you have been formally diagnosed with diabetes?

If you’re not getting your HbA1c checked regularly you can use the average blood glucose results from your home blood glucose meter (i.e. fasting, before meals and after meals). The conversion between HbA1c and average blood glucose are shown in Table 16. I have also added risk levels based on the HbA1c values based on the cardiovascular disease data shown in Figure 11.

Table 16 HbA1c and blood glucose ranges

<table>
<thead>
<tr>
<th>risk level</th>
<th>HbA1c (mmol/L)</th>
<th>average blood glucose (mmol/L)</th>
<th>average blood glucose (mg/dL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>optimal</td>
<td>4.5</td>
<td>4.6</td>
<td>83</td>
</tr>
<tr>
<td>excellent</td>
<td>&lt; 5.0</td>
<td>&lt; 5.4</td>
<td>&lt; 97</td>
</tr>
<tr>
<td>good</td>
<td>&lt; 5.4</td>
<td>&lt; 6.0</td>
<td>&lt; 108</td>
</tr>
<tr>
<td>danger</td>
<td>&gt; 6.5</td>
<td>&gt; 7.8</td>
<td>&gt; 140</td>
</tr>
</tbody>
</table>

One of the most extreme proponents of the restricted carbohydrate dietary approach is Dr Ron Rosedale says that carbohydrates cause oxidation in the body, and we should do everything we can

45 http://www.cardiab.com/content/12/1/164
to minimise oxidation by minimising carbohydrates ingested. While the body does need glucose it is preferable to have the body make it via gluconeogenesis rather than directly feeding the body carbohydrates which will lead to oxidation.46

4.2.2 Mainstream recommendations
On the other extreme you have dieticians recommending the USDA food pyramid telling us that we can’t survive without our healthy whole gains and that our brains run on glucose and hence we need to eat carbs or else.

The generally accepted diagnosis levels for type 2 diabetes are shown in Table 17. Currently one in twelve adults worldwide are classified as diabetic based on this criteria. This number is forecast to grow by more than half over the next two decades to 592 million people by 2035.47

<table>
<thead>
<tr>
<th>Table 17 Type 2 blood glucose diagnosis levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>“normal”</td>
</tr>
<tr>
<td>Pre-diabetic</td>
</tr>
<tr>
<td>Type 2 diabetic</td>
</tr>
</tbody>
</table>

Comparing these diabetes diagnosis criteria with the optimal levels shown in Table 16 it’s clear that blood glucose that are considered “normal” are far from optimal. By the time you’re “pre-diabetic” you’re well into the danger zone!

4.2.3 The middle ground?
Somewhere between the dieticians and the low carb community you have people such as Paul Jaminet, Chris Kresser and Robb Wolf who advocate for some carbohydrates for the majority of the population.

When you listen to the argument a little closer it’s interesting to find that even these respected health experts are all talking about a level of carbohydrates much less than the typical western dietary intake and the typical mainstream recommendation.

Chris Kresser recommends 20 to 30% carbs for healthy people and says that a lower carb ketogenic approach will likely be beneficial for people with Alzheimer’s, dementia or neurodegenerative disorders.48

Paul Jaminet’s definition of “low-carbohydrate” means eating less than the body’s glucose utilisation which forces the body to make up the deficit via gluconeogenesis.49 Jaminet says that the body’s preferred source of fuel is fat. However the body typically runs on a mix of around 30% glucose for fuel (or about 600 calories per day). While the body can get the glucose it needs from protein via gluconeogenesis it is less demanding for the body to get that glucose from carbohydrate containing foods.

46 https://vimeo.com/52872503
48 http://chriskresser.com/how-to-feed-your-brain from 9:25
Figure 12 shows this concept graphically. If we eat more than around 30% carbohydrates the liver will end up with more glucose than it can store and we will end up with excess glucose in the blood. The pancreas will secrete insulin to remove this excess sugar and store it as body fat. If we eat less than 30% carbohydrates the body will convert protein to glucose through gluconeogenesis, and the risk of excess sugar in the blood is reduced.

![Graph showing carbohydrate consumption versus glucose flux](image)

**Figure 12** Carbohydrate consumption versus glucose flux

### 4.2.4 The big picture

When you stand back and look at the big picture, most people are recommending that the general population should be consuming significantly less carbohydrates than the typical western diet.

There’s no perfect diet or level of carbohydrates that suits everyone. Active people or people who are not metabolically broken will be able to tolerate more carbohydrates because they will be burning them. People who are sedentary or obese (i.e. 70% of the western population these days) or those with blood glucose dysregulation should opt for a carbohydrate restricted approach.

Jaminet also points out that there is an ideal range for blood glucose as shown in Figure 13. While people operating in ketosis can tolerate lower blood glucose levels while being asymptomatic, extremely low levels of blood glucose will lead to decreased health and eventually death.
Similarly, at high levels of blood glucose we will get the numerous complications of high blood glucose and diabetes. Somewhere between these two extremes is an optimal blood glucose level which Dr Richard Bernstein puts at about 83mg/dL or 4.6mmol/L.

4.3 What is a well formulated ketogenic diet?

While everyone uses fat for fuel to some degree, a ketogenic diet aims to reduce insulin levels to a point where ketone levels are high enough to be measured in the blood, breath or urine.

According the chart in Figure 14 taken from a presentation by Dr Steve Phinney, a “well formulated ketogenic diet” (WFKD) contains between 3 and 20% carbohydrates and between 10 and 30% protein. Other dietary templates such as the Mediterranean or Paleo diets typically contain more carbohydrates and less fat.

**Figure 13 Optimal blood glucose range**

**Figure 14 Comparison of protein and carbohydrate percentages for various diets**

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51 [https://www.youtube.com/watch?v=zJGAbZlvrh8](https://www.youtube.com/watch?v=zJGAbZlvrh8)
53 [https://www.youtube.com/watch?v=2KYYnEAYCGk](https://www.youtube.com/watch?v=2KYYnEAYCGk)
The typical concern regarding restricted carbohydrate diets is that people will not get adequate nutrition (i.e. vitamins, minerals and amino acids). Diabetics, along with the general population, are advised to eat in line with the USDA Food Pyramid / My Plate guidelines which emphasise “healthy whole grains” while discouraging eating saturated fat and cholesterol.

Diabetics are told that they shouldn’t deprive themselves of any foods or to risk not getting adequate nutrition, but rather to “cover” any carbohydrates they eat with insulin (or treat with medications such as Metformin for type 2 diabetics).

4.4 Who is this so important?

When my wife was diagnosed with type 1 diabetes at ten she was advised to eat at least 130g of carbohydrates with every meal. The insulin dose was kept fixed to cover this fixed amount of carbohydrates. Then if she went low she had to eat more carbs raise her blood glucose.

Welcome to the everyday blood glucose roller coaster that takes over your life as a diabetic!

It wasn’t till after we got married and started thinking about having kids that we were able to find a doctor with an interest in diabetes who told her that she could tailor her insulin dose to what she wanted to eat (i.e. carb counting). The standard diabetes care seems to have incorporated Bernstein’s carbohydrate counting, however still advises that diabetics shouldn’t have to deprive themselves of anything. Like everyone else, they should eat a diet full of “healthy whole grains”.

During her pregnancies we’d go to see the endocrinologists at the hospital who would look at her blood glucose and tell her that they should be lower. We’d ask how to achieve this but they would have no useful response. It wasn’t until we discovered Paleo and then low carb through family members and social media that she found that she could improve blood glucose control through diet.

More recently by refining our diet to prioritize low insulinogenic, high fibre and high nutrient density foods I’m pleased to say that she’s been able to find another level of improved blood glucose control, increased energy and reduced depression and anxiety that so often comes with blood glucose dis-regulation. She’s now able to enjoy working as a teacher rather than just getting through the morning and needing to sleep the afternoon before picking up the kids.

Her only regret is that she didn’t discover this earlier so she didn’t have to spend decades living in a fog with limited energy.

Figure 15 shows the difference diet can make in the management of blood glucose, particularly for a type 1 diabetic. Most people who find success with this dietary approach find a massive improvement in quality of life and their state of wellbeing that makes it well worth the effort.
Figure 15 Continuous blood glucose data before (top) and after (bottom) switching to LCHF

Below is a post on the TYPEONEGRIT Facebook group from a mother of a type 1 diabetic child describing their interaction with her health care team to give you a taste for what it’s like to try to go against the main stream dietary advice.

We had our team meeting today to discuss LCHF... they are so terrified of this, even though we have great normal BG readings, behaviour improvements and learning improvements (noted by us, family, friends and his school) which they didn’t even acknowledge.

The nutritionist is concerned that he won’t be getting the micronutrients that only come from grains and the higher carb vegetables (grains are fortified), then her concern was the B vitamins 1, 3 and 6. We did our research and 3 and 6 we have an abundance of and B1 we may be deficient of but it doesn’t matter so much because B1 job is to help turn carbs into fuel.

Then the concern about Iron (what?! have you seen the meat and spinach listed?). Then it was calcium and magnesium (clearly they don’t have a clue about LCHF).

They said they are afraid this diet may cause future developmental harm. We said your diet WILL cause future harm and way more than developmental. Back and forth and on it went. We addressed their concerns with peer reviewed research, and respect to their limited knowledge.

We will be an open book and comply because I want them to learn that T1D care can be so much better than it has been up to now, and pave the way for the next families that wishes to do LCHF.

They will check for vitamins and minerals at his 3 month blood work (again special for our case, which we have to pay for).
Optimising nutrition, managing insulin

For the general population this isn’t such a big deal, but for diabetics and their carers it is a matter of life and death, or at least a decision that will greatly affect their quality and length of life.

The good news is that the blood tests mentioned in the case above came back showing that the child was getting excellent nutrition on the LCHF dietary approach and they’re now looking to write up this case study and use it to educate the diabetes doctors in Ontario.

4.5 Comparison of dietary approaches

In order to understand the differences between various dietary approaches I have compared a range of options as shown in Table 18. The shaded rows in the table are the scenarios evaluated in section 6. More details on the other options approaches can be found here or here.

The dietary approaches have been sorted based on the sum of the scores from their insulinogenic properties, their nutrient and vitamin score and their amino acid score. The dietary approaches listed at the top rank the best overall. The shaded rows are discussed in more

Table 18 Comparison of various dietary approaches

<table>
<thead>
<tr>
<th>approach</th>
<th>carbs %</th>
<th>protein %</th>
<th>fat %</th>
<th>fibre (g)</th>
<th>net carbs (g)</th>
<th>% insulin</th>
<th>vitamins &amp; minerals</th>
<th>protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>diabetic / ketosis – w/ liver</td>
<td>7%</td>
<td>29%</td>
<td>64%</td>
<td>26</td>
<td>9</td>
<td>17%</td>
<td>84</td>
<td>146</td>
</tr>
<tr>
<td>low calorie, high bulk, weight loss – w/ liver</td>
<td>16%</td>
<td>34%</td>
<td>50%</td>
<td>36</td>
<td>44</td>
<td>27%</td>
<td>95</td>
<td>146</td>
</tr>
<tr>
<td>ketosis with BPC &amp; liver</td>
<td>7%</td>
<td>21%</td>
<td>72%</td>
<td>17</td>
<td>18</td>
<td>15%</td>
<td>79</td>
<td>140</td>
</tr>
<tr>
<td>low calorie, high bulk, weight loss</td>
<td>16%</td>
<td>32%</td>
<td>52%</td>
<td>36</td>
<td>44</td>
<td>26%</td>
<td>92</td>
<td>143</td>
</tr>
<tr>
<td>diabetic / nutritional ketosis</td>
<td>8%</td>
<td>23%</td>
<td>69%</td>
<td>26</td>
<td>14</td>
<td>15%</td>
<td>76</td>
<td>136</td>
</tr>
<tr>
<td>Bernstein template</td>
<td>7%</td>
<td>24%</td>
<td>69%</td>
<td>17</td>
<td>18</td>
<td>17%</td>
<td>68</td>
<td>149</td>
</tr>
<tr>
<td>high fat, low carb – w/ liver</td>
<td>3%</td>
<td>10%</td>
<td>87%</td>
<td>6</td>
<td>9</td>
<td>7%</td>
<td>53</td>
<td>144</td>
</tr>
<tr>
<td>Whals’ Paleo Plus</td>
<td>18%</td>
<td>13%</td>
<td>69%</td>
<td>37</td>
<td>53</td>
<td>18%</td>
<td>77</td>
<td>129</td>
</tr>
<tr>
<td>athlete</td>
<td>25%</td>
<td>27%</td>
<td>48%</td>
<td>45</td>
<td>80</td>
<td>31%</td>
<td>83</td>
<td>138</td>
</tr>
<tr>
<td>ketosis with bacon and eggs</td>
<td>7%</td>
<td>18%</td>
<td>75%</td>
<td>11</td>
<td>24</td>
<td>15%</td>
<td>57</td>
<td>141</td>
</tr>
<tr>
<td>high veggies / paleo</td>
<td>17%</td>
<td>28%</td>
<td>55%</td>
<td>24</td>
<td>61</td>
<td>27%</td>
<td>72</td>
<td>140</td>
</tr>
<tr>
<td>high fat, low carb</td>
<td>3%</td>
<td>10%</td>
<td>87%</td>
<td>6</td>
<td>9</td>
<td>7%</td>
<td>38</td>
<td>146</td>
</tr>
<tr>
<td>Atkins diet</td>
<td>9%</td>
<td>32%</td>
<td>59%</td>
<td>9</td>
<td>36</td>
<td>24%</td>
<td>59</td>
<td>145</td>
</tr>
<tr>
<td>Mediterranean</td>
<td>45%</td>
<td>21%</td>
<td>34%</td>
<td>34</td>
<td>191</td>
<td>50%</td>
<td>71</td>
<td>142</td>
</tr>
<tr>
<td>Dr Axe – vegetarian</td>
<td>16%</td>
<td>17%</td>
<td>67%</td>
<td>11</td>
<td>69</td>
<td>23%</td>
<td>48</td>
<td>109</td>
</tr>
<tr>
<td>high fibre vegetarian</td>
<td>70%</td>
<td>23%</td>
<td>7%</td>
<td>143</td>
<td>207</td>
<td>54%</td>
<td>94</td>
<td>93</td>
</tr>
<tr>
<td>Zone</td>
<td>40%</td>
<td>30%</td>
<td>30%</td>
<td>44</td>
<td>156</td>
<td>47%</td>
<td>69</td>
<td>108</td>
</tr>
<tr>
<td>nutritional density on a budget</td>
<td>49%</td>
<td>30%</td>
<td>21%</td>
<td>19</td>
<td>226</td>
<td>61%</td>
<td>47</td>
<td>117</td>
</tr>
<tr>
<td>grains on a budget</td>
<td>62%</td>
<td>14%</td>
<td>24%</td>
<td>25</td>
<td>285</td>
<td>65%</td>
<td>54</td>
<td>107</td>
</tr>
<tr>
<td>fruitarian</td>
<td>91%</td>
<td>3%</td>
<td>6%</td>
<td>54</td>
<td>401</td>
<td>82%</td>
<td>55</td>
<td>64</td>
</tr>
</tbody>
</table>
Figure 16 shows the total score for the approaches graphically showing the components that make up the total score (insulin load, vitamins and minerals, and protein).

**Figure 16 Quantitative comparison of various dietary approaches**

The key learnings from this analysis are listed below:

- The highest ranking approaches involve organ meats. If you’re not in to liver then non-starchy vegetables are your next best option to maximise nutrients while keeping the insulin load low.

- The extreme high fat approach (3% carbs from spinach and 10% protein) does not provide optimal levels of vitamins and minerals. This style of approach may be useful for more extreme therapeutic treatments for epilepsy, Parkinsons, or cancer. However supplementation may be required if this approach were used over the long term.

- A diet with 80% calories from and 7% of calories from carbohydrates can meet most of the recommended daily intake values for vitamins and minerals.

- A diet with 75% fat and 10% carbohydrates from non-starchy vegetables we can achieve an optimal balance between vitamins and minerals and insulin load.

- The fruitarian and budget grains approaches both scored poorly across the board.

- Dietary approaches without animal products struggle to provide adequate amino acids, vitamins and minerals.

- Optimal nutrition can be provided using a range of macronutrient profiles. When we consider the insulin load, nutrients and protein quality the highest scoring dietary approaches used between 50 to 80% fat, 13 to 34% protein and 7 to 16% carbohydrates. Within this window we can then refine the diet based on the goals of the
individual whether they be weight loss, blood glucose control / ketosis or athletic performance.

4.6 What’s the optimum macronutrient ratio?

By reviewing each of the dietary approaches analysed I have calibrated a target insulinogenic ratio and macronutrient ratio based on different health and performance goals.

Table 19 notes some considerations for individuals in different situations with respect to their target macronutrient ratio.

Section 6 discusses the practical application of a controlled carbohydrate approach for different situations and different goals.

**Table 19 Recommended macronutrient profile for different people**

<table>
<thead>
<tr>
<th>Situation</th>
<th>Comment</th>
<th>carbs (%)</th>
<th>protein (%)</th>
<th>insulin (%)</th>
</tr>
</thead>
</table>
| Type 1 diabetic | • The aim for a type 1 diabetic is to minimise carbohydrates in order to normalise blood glucose and minimise insulin.  
• Type 1 diabetics will often eat a higher amount of protein. While protein also raises blood glucose and requires insulin the impact is smaller and slower and hence easier to manage. High levels of protein are fine if combined with restricted carbohydrate levels.  
• Type 1 diabetics should focus on low insulinogenic foods from the list in section 6.3 and choose lower carbohydrate meal options. | 5 – 10 | 15 – 30 | < 20 |
| Type 2 diabetic, weight loss or nutritional ketosis | • Someone aiming for weight loss or the reduction of blood glucose should aim to reduce carbohydrates and moderate protein to a point where they obtain excellent blood glucose control (see target blood glucose levels in Table 16).  
• Weight loss is likely to result naturally once insulin sensitivity is addressed and the body can use stored body fat for fuel. | 5 – 20 | 10 – 20 | < 25 |
| Metabolically healthy / athlete | • Someone who is metabolically healthy can consume a wider range of macronutrients and select from a wider range of foods.  
• Endurance athletes may choose to use a restricted carbohydrates approach to train their body to be more metabolically flexible and thus avoid ‘bonking’ in endurance events.  
• In order to avoid fat storage and insulin resistance, carbohydrate intake should not exceed the body’s natural fuel energy balance of 30% carbs.  
• An athlete may desire higher amounts of protein to rebuild muscles, particularly if the aim is strength rather than endurance. | 5 – 30 | 10 – 35 | < 50 |

4.7 My n=1 experiment

I believe that blood glucose is a better indicator of overall health than body weight or BMI. Monitoring blood glucose levels before and after meals and manipulating the diet to achieve excellent blood glucose control is an ideal way to optimise and regain metabolic health.
If you are not achieving this level of blood glucose control or not happy with your current level of body fat I recommend that you reduce your dietary insulin load, possibly in combination with periods of intermittent fasting or fat fasts to kick start your insulin sensitivity.

While it may seem weird to prick yourself to test your blood glucose on a regular basis, it is actually relatively simple and pain free once you get over the initial fear of seeing a little bit of your own blood.

Over the years I’ve gone through stages where I’ve measured my blood glucose to understand how it correlates with what I eat and periods when I’ve had more stress and higher levels of body fat. Figure 17 shows my blood glucose over the last six months. While like to think I’m health conscious it was alarming to see my blood glucose drifting up towards the end of 2014. I was also finding it hard to reliably achieve consistent ketone readings. I had also been losing some weight through 2014 but not as much as I would have liked, particularly given large amounts of exercise I was doing.

![Figure 17 Blood glucose measurements – August 2014 to March 2015](image)

I had four weeks off over the Christmas break and towards the end of the holidays I was able to intensify my kettlebell training and cycling as well as starting intermittent fasting three days per week after coming across Jason Fung’s YouTube lectures.

After starting intermittent fasting my blood glucose started to drop and the ketones rose. I found that without really trying I was able to stick to a lower carbohydrate diet and had fewer cravings for junk once I tapped into a more consistent state of consistent nutritional ketosis.

During this time I have been able to drop weight much more easily without feeling like I’m depriving myself or feeling hungry. It seemed that the reduced stress and intermittent fasting led to lower blood glucose and higher ketones which led to reduced cravings and then weight loss. Though they’re all related it didn’t feel like it started with will power induced dietary control.

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54 Part of the reason for this could have been high levels of stress and exhaustion leading up to the end of a big year and a long stint of intensity at work without enough breaks and rest.

55 Check out the patient resources at [http://intensivedietarymanagement.com/patient-resources/](http://intensivedietarymanagement.com/patient-resources/)
Figure 18 shows my weight over the same time period. As my blood glucose started to come under control the weight came off relatively effortlessly. I’m pleased to say that I have now reached my target weight suggested by my doctor and I feel great with heaps of energy.

My only regret is knowing that I would have got there quicker if it hadn’t been for some indulgence around my son’s 9th birthday party when there might have been some pizza and garlic bread to “clean up”. Although I ate way too much of this stuff I was still hungry. It was much less satiating than the higher fat foods that I had been typically eating. As you can see from the weight chart there was substantial weight gain (including water weight with the increased glycogen) which then took a few weeks to get rid of.

The average of my blood glucose over the last twenty readings (both before and after meals) is sitting at around 5.1 which puts me in the “excellent” risk level in Table 16. Now I have reached my target my plan is to keep testing my blood glucose every week or so when I weigh myself, and adjust the insulin load of my diet as required to stay between optimal and excellent.

Table 20 HbA1c and blood glucose ranges

<table>
<thead>
<tr>
<th>risk level</th>
<th>HbA1c (mmol/L)</th>
<th>average blood glucose (mmol/L)</th>
<th>average blood glucose (mg/dL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>optimal</td>
<td>4.5</td>
<td>4.6</td>
<td>83</td>
</tr>
<tr>
<td>excellent</td>
<td>&lt; 5.0</td>
<td>&lt; 5.4</td>
<td>&lt; 97</td>
</tr>
<tr>
<td>good</td>
<td>&lt; 5.4</td>
<td>&lt; 6.0</td>
<td>&lt; 108</td>
</tr>
<tr>
<td>danger</td>
<td>&gt; 6.5</td>
<td>&gt; 7.8</td>
<td>&gt; 140</td>
</tr>
</tbody>
</table>

It’s also encouraging to see friends and family experience the benefits of this approach:

- My friend Bruce has been consistently doing low carb luxurious breakfasts for a while and has successfully lost around thirteen kilograms.
- My dad who has been using a high fat highly nutritious diet for the past year threw in some periods of intermittent fasting, monitoring of blood glucose and ketones along with eating to satiety rather than to a program on non-fasting day, and has been able to loose around four kilos.
- I caught up with a friend Greg recently who has lost about 45kg from following a LCHF type approach. Exciting stuff!
4.8 Ketone measurements

After Jimmy Moore’s Keto Clarity\textsuperscript{56} came out I bought a blood ketone meter\textsuperscript{57}. Figure 19 shows my ketone values over the past six months. Again, the higher levels of ketones also correspond to lower blood glucose and weight loss.

![Figure 19 Ketone values – August 2014 to March 2015](image)

In Australia and Canada blood glucose strips are about $0.16 compared to blood ketone strips which are about $0.80.\textsuperscript{58} In the US ketone strips are much more, and basically unaffordable.

Ketostix (which measure ketones in your urine) will typically work for a little while. But once you get fat adapted and your body adjusts to using ketones for energy you may no longer show ketones in your urine even though you might be have high levels of ketones in your blood.

4.9 The relationship blood ketones and blood glucose

Blood glucose can also be a useful proxy to see if you’re in ketosis and a good way to reduce the expense and pain.

Figure 20 shows my blood glucose versus ketones over the last nine months or so that I’ve been trying to achieve nutritional ketosis. I’m in light nutritional ketosis when by blood glucose are at less than 5.4mmol/L (100mg/dL) and in “optimal nutritional ketosis” when my blood glucose are at around 4.8mmol/L (90mmol/L).

The point way out to the right with a high ketone level of 2.1mmol/L and a blood glucose of 4.0mmol/L occurred after I rode to work two days in a row on Bulletproof Coffee with a good amount of MCT oil.

\textsuperscript{56} http://www.amazon.com/Keto-Clarity-Definitive-Benefits-Low-Carb/dp/1628600071
\textsuperscript{58} http://www.ebay.com.au/itm/BEST-PRICE-10-X-ABBOTT-FREESTYLE-OPTIUM-KETONE-TEST-STRIPS-10-TOTAL-100-STRIPS/181527585627?_trksid=p2054897.c100204.m3164&_trkparms=aid%3D222007%26algo%3DSIC.MBE%26ao%3D1%26asc%3D20140407115239%26meid%3Db2cedda776824d9f8ed5d131a3232ea7%26pid%3D100204%26rk%3D3%26rkt%3D24%26sid%3D281508543955
In *The Art and Science of Low Carbohydrate Performance* Volek and Phinney say that “light nutritional ketosis” is between 0.5mmol/L and 1.0mmol/L and “optimal ketosis” is between 1.0mmol/L and 3.0mmol/L.

It’s interesting to note though that Sami Inkenen when rowing from the US to Hawaii on an 80% fat diet was only getting ketones of around 0.6mmol/L. Many people in body building forums suggest that lower levels of blood ketones are better than high ketones.

If you’re striving for mental focus then loading up with butter, coconut oil and MCT oil to ramp up your ketones might be for you. However if your aim is exercise performance or fat loss then light nutritional ketosis might be where you want to be, with ketones from your body fat being burned for fuel rather than just having high levels of ketones from dietary fat building up in your blood.

Dr Dominic D’Agostino recommends noting times when you feel great and then measuring your blood glucose and ketones. Over time you’ll get a feel for what works best for your continue to manipulate your diet to achieve those goals. Maybe you feel best when your ketones are 1.5mmol/L and your blood glucose is 4.7mmol/L. Or maybe you just don’t feel great in ketosis and need to eat a few more carbs and protein to stay just outside of nutritional ketosis.

Conversely it could be interesting to measure blood glucose and ketones when you feel poor. Does that correspond to times when you blood glucose are high and you’re not registering any ketones?

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60 [https://gumroad.com/l/CK219](https://gumroad.com/l/CK219)
62 [https://twitter.com/samiinkinen/status/451089012166385664](https://twitter.com/samiinkinen/status/451089012166385664)
63 [https://www.facebook.com/ketogains](https://www.facebook.com/ketogains)
64 [https://www.facebook.com/ketogains](https://www.facebook.com/ketogains)
If you are showing some level of ketosis (say greater than 0.4mmol/L) when you test occasionally and have excellent blood glucose then I think that’s enough. You don’t necessarily have to go to the expense of measuring blood ketones on a regular basis.

I also think aiming for high levels of ketones by loading up on dietary fat at the expense of getting adequate protein, vitamins and minerals can be counterproductive.

4.10 Comparison of insulin load and glycaemic load for low carb diets

In section 2.8 I talked about the differences and similarities between the glycemic load and the insulin load.

Using the glycemic load helps us avoid sharp rises in blood glucose beyond what your pancreas insulin sensitivity tolerate. Managing the insulin load of our diet allows to optimise our blood glucose overall, reduce insulin levels and remain metabolically flexible and access our body fat stores.

Targeting insulin load rather than glycaemic load allows us to get to the root of the problem rather than managing blood glucose which is more of an indirect symptom.

The formula for the calculation of the insulin load is:

\[
isulin\ load\ (g) = carbohydrates\ (g) - fibre\ (g) + 0.54 \times protein\ (g)\n\]

In order to understand the similarities and differences between these two parameters, Table 21 shows a comparison of the insulin load versus the glycemic load (from NutritionData) for the various dietary approaches discussed in section 6 for a 2000 calorie per day diet. Figure 21 shows insulin load versus glycemic load plotted for a range of dietary approaches.

There are a lot of similarities between these two measurements, particularly for higher levels of carbohydrates. Considering the insulin load is more useful at lower levels of carbohydrate because the insulin load accounts for the impacts of both protein and fibre rather than just carbohydrate alone.

**Table 21 Comparison of insulin load and glycaemic load for different dietary approaches**

<table>
<thead>
<tr>
<th>Dietary approach</th>
<th>fibre (g)</th>
<th>net carbs (g)</th>
<th>protein (g)</th>
<th>insulin load (g)</th>
<th>GL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low calorie, high bulk, weight loss</td>
<td>36</td>
<td>44</td>
<td>160</td>
<td>130</td>
<td>24</td>
</tr>
<tr>
<td>Diabetic / ketosis / weight maintenance</td>
<td>26</td>
<td>14</td>
<td>115</td>
<td>76</td>
<td>12</td>
</tr>
<tr>
<td>athlete</td>
<td>45</td>
<td>80</td>
<td>135</td>
<td>153</td>
<td>70</td>
</tr>
<tr>
<td>nutritional density on a budget</td>
<td>19</td>
<td>226</td>
<td>150</td>
<td>307</td>
<td>160</td>
</tr>
</tbody>
</table>
So what should we be aiming for? How low is low enough?

Jimmy Moore in *Keto Clarity*\(^{66}\) recommends dropping your carbohydrates to around fifty grams per day and then moderating back your protein to around one hundred grams per day and then tweaking until you’re showing greater than 0.5mmol/L ketones on blood tests. This would equate to an insulin load of around 100g per day.

This seems to be a reasonable starting point. Start here and keep refining your insulin load until your blood glucose are somewhere between excellent and optimal by tweaking the amount of carbs, protein and fibre in your diet.

Over time you will get a good feel for what works and you can back off on the measuring and enjoy eating and life! Even though I’m an engineer I know that it’s not natural to have to measure and monitor everything you eat in the long term.

### 4.11 Stress

Stress and sleep are also recognised as being important factors to manage to minimise your risk of developing insulin resistance and obesity. I’ve been hearing a lot of people talk lately about the importance of sleep and meditation. And yes, there’s even an app for that.

I encourage you to check out the following apps that I have found helpful to quantify and understand sleep and stress, which are also critical to health and weight loss:

- **SweetBeat**\(^{67}\) - measures your heart rate variability (HRV) and provides feedback on your nervous system and degree of exhaustion. A high HRV score means you are well rested and ready to give your best. A low score might mean that you need to relax and de-stress for a while before you burn out and crash completely.

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- BreathSynch\(^{68}\) - Similar to SweetBeat, but uses the camera on your iPhone rather than a heart rate strap to measure your heart rate. This app teaches you to relax and breathe in sync with your heart to achieve a state of ‘coherence’. You only have to do it for three minutes per day and it is less boring than other forms of meditation or relaxation that I’ve tried.

- Sleep Cycle\(^{69}\) - Tracks your sleep quality and duration via the accelerometer in your iPhone and wakes you up at the top of your sleep cycle. Useful to make sure you’re getting a good duration and quality of sleep.

\(^{68}\) [http://www.breathesync.com/](http://www.breathesync.com/)

5 Nutrient Density

5.1 General
A number of attempts have been made to rank foods in terms of nutrient density. This section reviews some of these, discusses their limitations, and describes a method for ranking foods based on their nutrient density along with their insulinogenic properties, to quantitatively prioritise food choices.

5.2 Mat Lalonde’s nutrient density
Most recently Dr Mat Lalonde undertook a ranking of foods based on nutrient density in terms of nutrients per weight of food consumed.

Lalonde’s calculations used the full USDA food database of nearly eight thousand foods and devises a ranking based on what he considers to be the essential nutrients per 100g of food. This analysis identified organ meats as one of the more nutritious foods, with vegetables coming in second. Fruits and grains landed much further down the list.

The findings of Lalonde’s approach aligns well with the Paleo community’s approach to nutrition and hence was well received in these circles.

In his presentation at the 2012 Ancestral Health Symposium Lalonde noted that people wanting to lose weight may wish to prioritise in terms nutrient density per calorie, however he had chosen to analyse nutrient density in terms of weight as that might be more relevant for athletes (Lalonde is a CrossFit athlete as well as a biochemist) who need to refuel with nutrient dense foods rather than not getting enough energy from low calorie density foods.

As someone who would like to perhaps lose a bit more weight I was left wondering what the ranking might look like in terms of calories, or maybe other possible measures.

5.3 Aggregate Nutrient Density Index (ANDI)
Joel Fuhrman’s Aggregate Nutrient Density Index (ANDI) ranks foods based on their micronutrients per calorie but excludes a number of essential vitamins and minerals while placing extra emphasis on the oxygen radical absorbance capacity.

As noted by Chris Masterjohn, this approach heavily biases plant foods and seems to ignore the nutritional benefits of animal foods. Kale ranks at the top of the list with the maximum score of 1000, largely due to its massive amount of vitamin K. Unfortunately a massive dose of vitamin K isn’t much use to us in the context of a low fat diet if vitamin K (along with A and D) is a fat soluble vitamin. It’s also not much use having a food that is extremely high in one nutrient but not so good in a number of other areas. I would be best to find foods that provide a good spread of nutrients by limiting the maximum score from any one nutrient.

5.4 Dave Asprey’s Bulletproof Diet
Dave Asprey has developed the Bulletproof Diet Infographic which is a simple ranking of foods to avoid and focus on based on both nutritional density and toxins. The downside of this simple visual

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71 [https://www.youtube.com/watch?v=HwbY12q2cF4](https://www.youtube.com/watch?v=HwbY12q2cF4)
guide is that it shows only a select range of foods and doesn’t explain why each of the foods has the ranking that is has been given (though there is some discussion of the toxins and various issues in the book).

Most people would be happy with this visual list of foods to preference and avoid, however I wanted to see the numbers to understand why one food ranked above another.

5.5 JJ Virgin’s Sugar Impact

Another ranking system that I came across recently was in JJ Virgin’s Sugar Impact Diet which ranked foods according to the amount of sugar in each food. While this is useful the list was limited and doesn’t consider nutrient density or other forms of carbohydrate which also raise blood glucose.

5.6 Soylent

A couple of years back I came across Soylent, a food product designed by software engineer Rob Rheinhart.

Rheinhart, who doesn’t much like to cook, developed a formula-based food that theoretically covered all the recommended daily nutrient allowances (RDA) along with a few other nice to haves such as sulphur.

What started with a blog post describing Rheinhart’s personal journey to create a cheap and hassle free gruel that would cover off on all his nutritional needs quickly captured peoples’ imagination and attracted $1M in Kickstarter funds to develop the product for the mass market.

While I’m not a big fan of the idea of eating meal replacement shakes on a regular basis it was interesting to see how, in the vacuum of widespread distribution of Soylent, a number of websites and blogs started up with people sharing their recipes for their own version of Soylent tailored for their micronutrient and macronutrient needs.

It was clear that hundreds, maybe thousands of people had designed their own brew, ordered the ingredients online, and were making their own version of Soylent in their own kitchen. Some of these DIY products consisted primarily of chemicals and supplements, while others were more like green smoothies on steroids. Some were high carb, some were ketogenic, depending on the goals of the person trying to develop them. All were analysed and optimised in a spreadsheet or a database to ensure that they ticked all the boxes of nutrient sufficiency across a wide range of nutrients.

You probably wouldn’t be surprised that I had a go at developing my own Soylent-style shake. The ingredients included protein powder, coconut oil, egg, almonds and chia seeds plus a number of other additives that arrived on my doorstep via the eBay and Amazon.

75 http://www.amazon.com/JJ-Virgins-Sugar-Impact-Diet/dp/1455577847
76 http://www.soylent.me/
77 http://robrhinehart.com/?p=298
78 While you may be able to design a fortified vitamin and mineral infused shake that ticks all the RDA boxes better than any single real food found in nature, I think it always be preferable to get the majority of your intake form real foods. Vitamins and minerals in foods are typically absorbed better in the context of other foods rather than single ingredients. If you’re relying on your vitamin supplements for your primary nutrition you’re on shaky ground. There’s also a good chance that there are vitamins and minerals in real food that aren’t yet part of the RDA checklist that we would likely be missing out on if we just consume the vitamins and minerals on the list.
Along with a daily multivitamin this meal replacement shake ticked all the nutrient boxes. I’ve included it in my meal analysis ranking spreadsheet as part of this process and it sits about midway in the meal ranking spreadsheet.

While I don’t think it’s ideal for people to be eating large amounts of manufactured food smoothies for a range of reasons I was impressed by this community of people who were so passionate about and enamoured by developing a tailored dietary approach and then sharing it with the rest of the community for them to use and maybe improve on. It was like an open source nutrition competition!

Wouldn’t it be great if people with similar goals (e.g. paleo, LCHF, low carb, ketogenic, and diabetic communities) pooled their intellect and passion to develop an optimised approach to nutrition? What if there was a way that people could rank dietary approaches based on their own goals rather than always against the US Department of Agriculture food pyramid? (See section 6.8 for details of what I think to be an exciting system to rank and compare meals based on insulin load, nutrients and protein quality).

5.7 Nutrient density versus cost

After searching to try to find Lalonde’s spreadsheet online I came across a food ranking system in terms of nutrient density per dollar.

Building on the work of Mat Lalonde, Dale Cumore of the blog Solving Nutrition had created a ranking based on nutrient density per dollar cost of that food to arrive at the cheapest way to get nutrition for around 1000 foods that he could find cost data for.

If we simply rank by nutrients divided by cost we end up with tea, coffee, liver, parsley, and oat bran bagels up the top of the list along with things like condensed juices and then fortified milks. This is interesting, however we really need to drop out the fortified and condensed products to get a better picture of things that a normal person would eat and drink on a regular basis.

After dropping out the fortified products, we get the following list of foods based on nutrient density per dollar:

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| 1. bagels                          | 10. beef liver                     | 18. peanuts        |
| 2. French rolls                   | 11. spaghetti                      | 19. chives         |
| 3. croissants                    | 12. Chinese cabbage (Bok Choy)     | 20. whole eggs     |
| 4. muffins                       | 13. sunflower seeds                | 21. brown rice     |
| 5. lentils                       | 14. White bread                    | 22. sweet potato   |
| 6. tortillas                     | 15. chicken liver                  | 23. cabbage        |
| 7. rice                          | 16. peanut butter                  | 24. orange juice   |
| 8. parsley                       | 17. skim milk                      |                  |
| 9. energy drink                  |                                          |                  |

While grains are obviously a cost effective way to get calories and nutrients, we also need to consider other negative effects of foods. Many people believe that most if not all grains should be avoided.\(^{81}\)

Unfortunately grains are not ideal for everyone. My ten year old daughter knows that if she eats bread she will end up with a stomach ache and dark circles around her eyes.

### 5.8 Cost per calorie

Cost will always be a consideration to some degree - some people may not have the finances to buy grass fed and organic while others will have the means to invest in food as medicine.

Listed below are the cheapest foods in terms of cost per calorie. Not surprisingly grains (including white rice), candy and sugar rank up there with some of the cheapest ways to get calories.\(^ {82}\)

| 1. pumpernickel rolls     | 8. coconut oil                    | 15. cake mix        |
| 2. croissants             | 9. granulated sugar                | 16. peanut butter    |
| 3. bagels                 | 10. rice                          | 17. cranberry juice  |
| 4. canola oil             | 11. brown sugar                    | 18. spaghetti        |
| 5. French rolls           | 12. mayonnaise                     | 19. sausage          |
| 6. margarine              | 13. doughnuts                      | 20. corn starch      |
| 7. what muffins           | 14. tortillas                      | 21. graham crackers  |

One of the criticisms of LCHF and Paleo dietary templates is that these foods are expensive. However it’s worth noting that a number of fats and oils also rank highly in the calories per dollar list, including coconut oil in the list above.

While it’s true that grass fed beef, salmon and organic vegetables can be more expensive than boxed cereals and sugar, obtaining significant proportion of your calories from fats such as coconut oil and butter can actually be very cost effective on a per calorie basis.

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\(^{81}\) [https://www.youtube.com/watch?v=VvfTV57jPUY](https://www.youtube.com/watch?v=VvfTV57jPUY)

\(^{82}\) If you wanted to view this cynically you could say that the fact that grains and sugars have the lowest cost per calorie enables food manufacturers to place the largest mark up on these foods when reselling them in cardboard boxes in the supermarket. It’s harder to put a bar code on generic vegetables and meat products that are already relatively expensive.
5.9 Nutrient density per calorie

Nutrient density per calorie is a useful metric for someone wanting to lose weight, maximise nutrition and minimise calorie intake. One line of health and weight loss thinking says that once the body obtains adequate nutrients it will stop searching for food and unnecessary hunger will be minimised.

In chapter 17 of the Perfect Health Diet Paul Jaminet’s notes that a nourishing, balanced diet that provides all nutrients in the right proportions is the key to eliminating hunger, minimising appetite and eliminating hunger with a minimal caloric intake. This is the key to long term weight loss.

Using this rationale vegetables shoot to the top of the list with things spinach, turnip, lettuce, kale, mushrooms and asparagus ranking really well. Less common foods such as beef liver and chicken liver, spices, oysters, and cod also rank high in this list.

1. spinach 8. goose liver 15. dandelion greens
2. chicken liver 9. turnip greens 16. basil
3. beef liver 10. mustard greens 17. caviar
4. beet greens 11. parsley 18. kale
5. veal liver 12. chard 19. broccoli
6. pork liver 13. oyster 20. All bran
7. duck liver 14. coriander 21. collards

5.10 Fibre per calorie

Obtaining adequate fibre is important, especially if on a diet that doesn’t restrict carbohydrates or sugar.\(^83\)

Typical daily fibre intake for those in western civilisations is around 17g. It is said that African hunter gatherer children obtain more than 150g of fibre per day from eating unprocessed foods in their natural state\(^84\) and before the invention of fire and cooking foods to increase the caloric density of our foods our ancestors were eating between 100 and 300 grams of fibre per day.

As discussed in section 2.2, fibre in carbohydrate-containing foods neutralises the insulinogenic effects. Fibre is not digestible by the human gut and hence it does provide energy or cause a rise in blood glucose or insulin.

The mainstream recommendation is to get at least 30g of fibre per day to improve your blood glucose and cholesterol levels. Most people don’t achieve these levels even when eating “healthy whole grains”, largely due to the high level of processing in most popular foods.

Ironically the primary recommended source of fibre is from “healthy whole grains”. While whole grains will be marginally better than processed grains such as white bread, they will have a higher glycemic load and hence be much more insulinogenic than other options such as non-starchy

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\(^83\) One of the more exciting concepts in the diet space recently is the concept that what you eat could possibly change your gut bacteria for better or worse. While this area is still in its infancy the thinking is that lean people have a higher bacteriodes : fermicutes ratio and that this can be influenced by eating more fibre / prebiotics. Though at the same time it is not clear if just eating high fibre vegetables will lead you to being lean and having good gut bacteria at the same time.

\(^84\) [http://www.abc.net.au/catalyst/stories/4067184.htm](http://www.abc.net.au/catalyst/stories/4067184.htm)
vegetables. The end result in increased blood glucose and cholesterol levels that the fibre was meant to be assisting us with.

While fruit is an improvement compared to fruit juice they may still have an unacceptable effect on people who are not able to regulate their blood glucose.

If we rank for fibre per calorie we end up with a few spices such a cinnamon, curry powder, or cocoa at the top of the list along with veggies such as turnip, artichoke, sauerkraut, cauliflower. Cereals and grains (which are typically recommended for fibre) are much further down the list. All Bran features in the list below due to the fact that is has been fortified with added fibre.

1. cinnamon
2. turnip greens
3. artichoke
4. curry powder
5. sauerkraut
6. cauliflower
7. raspberries
8. lettuce
9. blackberries
10. lemon peel
11. All Bran (w/ added extra fibre)
12. oregano
13. wheat bran
14. eggplant
15. basil

Many people will say that carbohydrates aren’t such a big deal if they are eaten in their natural forms and that it’s not carbohydrates per se, but rather the quality of the food and the level of processing and that most people can tolerate carbohydrates in their natural form.\(^\text{85}\)

While probably not a perfect metric, the fibre content in natural foods (preferably with minimal levels of cooking) appears to be a good proxy for their quality and level of processing.

We have also seen that the fibre in foods reduces the insulin reaction and offsets the effect of carbohydrates and protein. This is all packaged into the following formula

\[
\text{insulin load (g)} = \text{carbohydrates (g)} - \text{fibre (g)} + 0.54 * \text{protein (g)}.
\]

\(^\text{85}\) [http://chriskresser.com/is-the-glycemic-index-useful](http://chriskresser.com/is-the-glycemic-index-useful)
6 Your personalised food ranking system

6.1 General

The range of measurements discussed in section 4 and the insulin load food discussed in section 3 can be combined to prioritise food choices to suit an individual’s goals.

In this section we look how we can use the food ranking system for a range of different people who may have one of the following goals:

1. weight loss,
2. optimising blood glucose / nutritional ketosis,
3. optimal nutrition on a budget; and
4. athletic performance.

For each of these scenarios I have developed an example meal plan with a nutritional analysis that could demonstrate how each approach could be applied (though there are a wide range of food choices highlighted that one could choose from based on personal taste).

6.2 Scenario 1 – Weight loss through reduced calorie density, high bulk

Figure 22 shows the macronutrient ratio of four phases of a ketogenic diet according to Steve Phinney.\(^86\)

<table>
<thead>
<tr>
<th></th>
<th>ADAPT</th>
<th>ADJUST</th>
<th>BUILD</th>
<th>MAINTAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (lbs)</td>
<td>200</td>
<td>180</td>
<td>160</td>
<td>150</td>
</tr>
<tr>
<td>Intake (kcal/day)</td>
<td>1400</td>
<td>1800</td>
<td>2150</td>
<td>2200</td>
</tr>
<tr>
<td>Expenditure (kcal/day)</td>
<td>2800</td>
<td>2600</td>
<td>2400</td>
<td>2200</td>
</tr>
<tr>
<td>Carb Intake (g/day)</td>
<td>35</td>
<td>45</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td>Weight (fat) Loss (lbs/week)</td>
<td>2.8</td>
<td>1.7</td>
<td>0.5</td>
<td>0</td>
</tr>
</tbody>
</table>

![Figure 22 Stages of a ketogenic diet](https://www.youtube.com/watch?v=8NvFyGGXYiI&index=1&list=PLrVWtWmYRR2BIAsGG9tr6T-B4xSum8SCc)

In the early phases of a ketogenic diet when people try to restrict carbohydrates they will naturally reduce their overall calorie intake due to increased satiety. With total calories and insulin levels low and excess body fat to burn, a lot of the energy expenditure will come from stored body fat. As time

\(^{86}\) [https://www.youtube.com/watch?v=8NvFyGGXYiI&index=1&list=PLrVWtWmYRR2BIAsGG9tr6T-B4xSum8SCc](https://www.youtube.com/watch?v=8NvFyGGXYiI&index=1&list=PLrVWtWmYRR2BIAsGG9tr6T-B4xSum8SCc)
passes and weight is lost, people will naturally progress a maintenance stage with slightly higher calorie intake and more dietary fat.

This scenario is designed for someone wanting to lose weight by selecting high nutrient density, high fibre, and low calorie density foods. The food selection will ensure the dieter is kept full and satisfied by eating a large volume of high fibre foods with low calorie density.

The weighting of the various metrics used in this scenario are shown below, with an emphasis on high nutrient density (20% weighting), high fibre (10% weighting), and low calorie density (30% weighting).

Some attention is paid to the insulinogenic properties of the foods (25% weighting) though not as much as if we were designing a diet for a diabetic or someone looking to achieve nutritional ketosis without intentionally restricting calories.

Retaining a 5% weighting for each of the cost parameters will avoid prioritising more obscure foods that are harder to get or are not typically eaten in large quantities as well as keeping cost reasonable and hence maintainable in the long term.

Foods are listed below, in order of priority, from the top 25% of foods sorted using this weighting. This approach looks a lot like a healthy vegetarian diet with some added fish and meat to achieve the required protein and amino acid intake.

This weighting brings high fibre, nutrient dense, non-starchy vegetables to the top of the list. This weightings does not prioritise added fats and oils as the fat in this style of ketogenic diet would ideally be coming from the body fat stores. The list of nuts and seeds is also quite short in view of their high nutrient density.

I have omitted some of the more obscure foods in order to make a list that is usable and not too long. If you want to delve into the detail of any of these foods I encourage you to look at the full spreadsheets available that are available in the files section at facebook.com/groups/optimisingnutrition.

### 6.2.1 Vegetables & spices
- spinach
- parsley
- coriander
- turnip greens
- collards
- chives
- mushroom
- chard
- rosemary
- dandelion greens
- curry powder
- broccoli
- Brussel sprouts
- kale
- mustard greens
- artichokes
- peas
- lettuce
- carrots
- cabbage
- lima beans
- sweet potato
- seaweed
- alfalfa seeds

### 6.2.2 Animal products
- organ meats (liver, kidney heart etc)
- herring
- sardine
- oyster
- ham
- ground chicken
- pork
- turkey
- duck
- frankfurter crab
- bacon
- mussels
- tuna
- trout
- salmon
Optimising nutrition, managing insulin

- beef

6.2.3 Fruits
- avocado
- olives
- raspberries
- blackberries

6.2.4 Dairy
- whole egg
- egg yolk
- ricotta cheese

6.2.5 Nuts, seeds & legumes
- lentils
- beans
- mung beans
- coconut milk
- chickpeas
- refried beans

6.2.6 Fats and oils
- butter
- coconut oil
- olive oil
- fish oil

6.2.7 Example daily diet - Low calorie, high bulk, weight loss

Table 22 shows an example daily meal plan for someone wanting to lose weight by reducing calorie density and maximise nutrition using the prioritised list of foods above.

The macronutrients and calories in this scenario are based on the “adjust” stage of the ketogenic diet shown in Figure 22. Protein is adequate to support muscle maintenance at 30% of dietary intake or 20% of total expenditure.

This approach will likely produce ketosis due to the low caloric content. Having low levels of carbohydrates and thus low insulin levels will enable body fat stores to be accessed for energy.

There’s nothing too radical or objectionable here other than the high amounts of nutrient dense green veggies that you would need to consume.

Some added fat is used for cooking, though not excessive amounts are required to reach the ketogenic macronutrient ratio. There are no snacks and no calorie dense nuts and seeds.
6.2.8 Nutritional analysis

In order to understand the nutrient sufficiency of this dietary approach I have analysed the daily meal plan using SELFNutritionData.\(^{87}\)

The outputs from the nutritional analysis shown below demonstrate that we achieve excellent scores in both nutrient balance and the protein quality using this approach. The overall ranking for this approach does quite well in the overall ranking of dietary approaches shown in Table 18.

This daily plan also has an impressive 36g of fibre per day and involves eating nearly two kilograms of food which would leave you feeling full if you could get through all this food, in spite of the reduced number of calories.

With the high amount of fibre, the net carbs are low and would meet our goal of less than 45g of carbs in the adjust phase of the ketogenic diet.

If you were really serious about maximising nutrient density you could substitute the meat at one of the meals for a nutrient dense organ meat (e.g. liver, heart, kidney etc.). Subbing out the salmon at dinner for chicken liver increases the nutrient balance score from 92 to 95 and the protein quality.

---

\(^{87}\) [http://nutritiondata.self.com/mynd/myrecipes](http://nutritiondata.self.com/mynd/myrecipes)
score from 143 to 146. This exchange would make this approach the second highest scoring in the comparison in Table 18.

6.3 Scenario 2 - Diabetic / nutritional ketosis / weight maintenance

This scenario uses a weighting system designed for a diabetic or someone trying to achieve nutritional ketosis through lowering insulin while keeping nutrient density high. The macronutrients and calories are based on the “maintain” phase of the ketogenic diet cycle as shown in Figure 22.

While someone who is overweight and insulin resistant may find that they lose weight due to lowered insulin, decreased fat storage and increased satiety, this approach is not designed specifically for weight loss. If someone wants to lose weight and does not have success on this approach they might benefit from decreasing calorie density and reducing added dietary fats as per scenario 1.

The nutrients per calorie (15% weighting), nutrient density per 100g (10%) and calories per 100g (10%) are emphasised in this scenario in order to find the most nutrient dense carbohydrates and proteins to enable the insulin lowering fats to be maximised in the rest of the diet. The dominant weighting in this scenario however is the proportion of insulinogenic calories (50% weighting) which takes into account the insulinogenic effects of the carbohydrates protein and the fibre.

<table>
<thead>
<tr>
<th>nutrient density / calorie</th>
<th>fibre / calorie</th>
<th>nutrient density / $</th>
<th>nutrient density / weight</th>
<th>insulin (%)</th>
<th>Calories / 100g</th>
<th>$ / calorie</th>
</tr>
</thead>
<tbody>
<tr>
<td>15%</td>
<td>5%</td>
<td>5%</td>
<td>10%</td>
<td>50%</td>
<td>10%</td>
<td>5%</td>
</tr>
</tbody>
</table>

The foods prioritised by this weighting are listed below in order of priority. Vegetables again rate well, with fats and oils coming up in priority with the increased focus on the insulinogenic properties of the foods. Fruits are limited to avocados and olives. There are a lot of egg and dairy options available if you can tolerate them along with a long list of nuts, seeds and legumes.
One thing I was surprised by was that peanuts do quite well with their high fat content and high fibre content which cancels out their moderate carbohydrate content.

It’s interesting to note that animal products are acceptable but the standard fare of beef and chicken (i.e. lean protein) aren’t at the top of the list. Organ meats and seafood appear to be better choices due to their higher nutrient and fat content. The omega 3 / DHA content of these foods are not included in the ranking system with cost, however this would be another reason to prioritise seafood.

6.3.1 Vegetables & spices
- curry powder
- spinach
- turnip greens
- coriander
- rosemary
- parsley
- peppers
- mushrooms
- chard
- cinnamon
- peppers
- artichokes
- broccoli
- Brussel sprouts
- kale

6.3.2 Fats and oils
- butter
- coconut oil
- olive oil
- fish oil
- flaxseed oil

6.3.3 Fruits
- avocados

6.3.4 Eggs & Dairy
- egg yolk
- whole egg
- goat cheese
- parmesan cheese
- cream
- camembert
- feta
- cheddar
- parmesan
- mozzarella
- ricotta

6.3.5 Nuts & seeds
- brazil nuts
- sunflower seeds
- peanuts
- pecans
- pumpkin seeds
- almonds
- macadamia nuts
- almond butter
- pine nuts
- flax seeds

6.3.6 Animal products
- organ meats (liver, kidney heart etc)
- sausage
- sardines
- chorizo
- bratwurst
- herring
- bacon
- mackerel
- duck
- frankfurter
- mackerel
- turkey
- beef steak
- lamb
- salmon
- oyster
- ham
- beef jerky

6.3.7 Example daily diet
Table 23 shows an example daily meal plan using the foods identified by this weighting system. Compared to the low calorie density weight loss approach, this scenario uses cream in coffees rather than black coffee, less spinach and vegetables and more calorie dense foods such as cheese and olives. I’ve also added in some brazil nuts for afternoon tea. Overall this approach is probably more viable in the long term as it involves a wide range of luxurious foods without as many restrictions as the low calorie density approach which emphasises more non-starchy vegetables. In reality most people would probably benefit from consuming a diet somewhere between scenario 1 and scenario 2 in the long term.
Table 23  Daily meal plan – diabetic / nutritional ketosis / weight maintenance

<table>
<thead>
<tr>
<th></th>
<th>Calories</th>
<th>Carbs</th>
<th>Fat</th>
<th>Protein</th>
<th>Potass</th>
<th>Sugar</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Breakfast</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Espresso - Espresso, 80 ml</td>
<td>12</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>70</td>
<td>0</td>
</tr>
<tr>
<td>Eggs - Fried (whole egg), 3 large</td>
<td>277</td>
<td>1</td>
<td>21</td>
<td>18</td>
<td>203</td>
<td>1</td>
</tr>
<tr>
<td>Cadet - Bacon, 2 Slices (40 gr)</td>
<td>220</td>
<td>0</td>
<td>20</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Spinach - Cooked, boiled, drained, with salt, 1 cup</td>
<td>41</td>
<td>7</td>
<td>0</td>
<td>5</td>
<td>639</td>
<td>1</td>
</tr>
<tr>
<td>Avocados - Raw, 0.5 avocado, NS as to Florida or California</td>
<td>161</td>
<td>9</td>
<td>15</td>
<td>2</td>
<td>487</td>
<td>1</td>
</tr>
<tr>
<td>Cream - Heavy whipping (whipped), 20 g</td>
<td>69</td>
<td>1</td>
<td>7</td>
<td>0</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>**Add Food</td>
<td>Quick Tools**</td>
<td>780</td>
<td>19</td>
<td>63</td>
<td>31</td>
<td>1,614</td>
</tr>
<tr>
<td><strong>Lunch</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Olive Oil, 1 tablespoon</td>
<td>119</td>
<td>0</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Spinach - Baby Spinach, 260 grams</td>
<td>46</td>
<td>7</td>
<td>1</td>
<td>16</td>
<td>1,116</td>
<td>1</td>
</tr>
<tr>
<td>Kalamata Olives - Kalamata Olives, 8 olives</td>
<td>25</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>John West - Tuna Olive Oil Blend, 95 g (71g drained)</td>
<td>139</td>
<td>1</td>
<td>8</td>
<td>17</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Feta - Feta, 20 g</td>
<td>57</td>
<td>0</td>
<td>5</td>
<td>3</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>Dulano - Chirizo , 50 g</td>
<td>213</td>
<td>1</td>
<td>18</td>
<td>11</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>**Add Food</td>
<td>Quick Tools**</td>
<td>599</td>
<td>11</td>
<td>49</td>
<td>47</td>
<td>1,428</td>
</tr>
<tr>
<td><strong>Dinner</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pork sausage - Fresh, cooked, 1 serving (2 links)</td>
<td>193</td>
<td>0</td>
<td>14</td>
<td>9</td>
<td>141</td>
<td>0</td>
</tr>
<tr>
<td>K-Classic - Camembert, 100 g</td>
<td>299</td>
<td>2</td>
<td>24</td>
<td>26</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Butter - Salted, 1 tbsp</td>
<td>102</td>
<td>0</td>
<td>12</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Broccoli - Cooked, boiled, drained, with salt, 200 g</td>
<td>58</td>
<td>19</td>
<td>1</td>
<td>6</td>
<td>588</td>
<td>3</td>
</tr>
<tr>
<td>**Add Food</td>
<td>Quick Tools**</td>
<td>620</td>
<td>12</td>
<td>51</td>
<td>35</td>
<td>730</td>
</tr>
<tr>
<td><strong>Morning Tea</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cream - Heavy whipping (whipped), 1 tbsp</td>
<td>52</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>Espresso - Espresso, 40 ml</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>35</td>
<td>0</td>
</tr>
<tr>
<td>**Add Food</td>
<td>Quick Tools**</td>
<td>58</td>
<td>1</td>
<td>6</td>
<td>0</td>
<td>46</td>
</tr>
<tr>
<td><strong>Afternoon Tea</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macro Organic - Brazil Nuts, 15 g</td>
<td>105</td>
<td>1</td>
<td>10</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>**Add Food</td>
<td>Quick Tools**</td>
<td>105</td>
<td>1</td>
<td>10</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

6.3.8  Nutritional analysis
The nutritional analysis of this meal plan shows that this approach gives us an excellent nutritional profile, though it does not score quite as highly on the vitamins and minerals and protein as the previous approach due to the reduced amount of vegetables. However, for someone aiming to manage their blood glucose closer to optimum levels this approach has a much lower glycemic load and a much lower proportion of insulinogenic calories than scenario 1.

This approach also achieves a very low 14g of net carbs per day due to the high amount of fibre from the vegetables. A diabetic on this dietary approach would find their insulin requirement was substantially reduced and their blood glucose would stabilise. Higher levels of ketones and weight loss would most likely ensure naturally after a period of time.

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88 Some people on a restricted carbohydrate diet find that they get what is called “physiological insulin resistance” where the muscles preference glucose for the brain and this leads to higher blood glucose. If you find that you are getting increased fasting blood glucose you may want to look at increasing your carbohydrate
If we substitute the pork sausages at dinner for chicken liver this scenario would achieve an exceptional nutrient balance score of 84 with a protein quality score of 148.

### 6.4 Scenario 3 - Nutrient density on a budget

This scenario prioritises nutrient density per dollar (30% weighting) and cost per calorie (30% weighting) without as much attention to calories, carbohydrates or keeping insulin levels low.

<table>
<thead>
<tr>
<th>nutrient density / calorie</th>
<th>fibre / calorie</th>
<th>nutrient density / $</th>
<th>nutrient density / weight</th>
<th>insulin (%)</th>
<th>calories / 100g</th>
<th>$ / calorie</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>5%</td>
<td>30%</td>
<td>5%</td>
<td>10%</td>
<td>10%</td>
<td>30%</td>
</tr>
</tbody>
</table>

This approach is not recommended for health, but rather as a comparison of what happens if we prioritise cost over nutrition or optimisation of blood glucose management (as is generally the case in the majority of most peoples’ diets, whether intentional or not).

This weighting prioritises grains, along with peanuts, potatoes, legumes and liver. While grains and legumes do not provide optimal nutrition they are cheap. They would not be ideal if you are conscious of your weight, blood glucose control or long term health.

#### 6.4.1 Legumes
- Peanut butter
- Lentils
- Chickpeas

#### 6.4.2 Grains
- Peanuts
- Kidney beans
- Mung beans
- Refried beans
- Tortillas

levels to a minimum of 30g per day (as recommended by Dr Bernstein). Other people however find that this is a stage and which passes after a longer period of adjustment to using fat for fuel.
Optimising nutrition, managing insulin

- Muffins
- Waffles
- Spaghetti
- Croissants
- French roll
- Oat bran bagel
- Rice
- White bread
- Crackers
- Multigrain bread

6.4.3 Vegetables
- Peppers
- Parsley
- Cowpeas
- Chives
- Spinach
- Dandelion greens
- Sweet potato
- Mushroom

6.4.4 Nuts and seeds
- Cabbage
- Chard
- Peas
- Brussel sprouts
- Kale
- Sunflower seeds
- Pumpkin seeds
- Brazil nuts
- Pistachio nuts
- Almonds

6.4.5 Dairy and egg
- Whole egg
- Reduced fat milk
- Egg yolk

6.4.6 Animal products
- Organ meats (Liver, heart, giblets)
- Herring

6.4.7 Fats and oils
- Turkey
- Sausage
- Pork
- Bratwurst
- Ham
- Chicken
- Margarine
- Corn oil
- Mayonnaise

6.4.8 Breakfast cereals
- Corn flakes
- All bran

6.4.9 Fruit
- Orange
- Avocado
- Banana

6.4.10 Daily meal plan

An example daily meal plan is shown below. Many people would see this as a reasonably healthy daily meal plan with cornflakes and a banana for breakfast, peanut butter sandwich for lunch (on multigrain bread), an orange for afternoon tea, and spaghetti and mince for dinner. It’s not too dissimilar to the meal plan that was recommended to me the one time I went to a nutritionist.
### Breakfast

<table>
<thead>
<tr>
<th></th>
<th>Calories</th>
<th>Carbs</th>
<th>Fat</th>
<th>Protein</th>
<th>Potassium</th>
<th>Sugar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kellog's Australia - Corn Flakes, 90 g / 1 Cup</td>
<td>338</td>
<td>75</td>
<td>0</td>
<td>7</td>
<td>84</td>
<td>7</td>
</tr>
<tr>
<td>Milk - Reduced fat, 2% milkfat, 3 cup</td>
<td>366</td>
<td>34</td>
<td>14</td>
<td>24</td>
<td>1,098</td>
<td>37</td>
</tr>
<tr>
<td>Bananas - Raw, 1 medium (7&quot; to 7.75&quot; long)</td>
<td>105</td>
<td>27</td>
<td>0</td>
<td>1</td>
<td>422</td>
<td>14</td>
</tr>
<tr>
<td>Coffee - Brewed from grounds, 1 oz(s)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>**Add Food</td>
<td>Quick Tools**</td>
<td>807</td>
<td>136</td>
<td>14</td>
<td>32</td>
<td>1,618</td>
</tr>
</tbody>
</table>

### Lunch

<table>
<thead>
<tr>
<th></th>
<th>Calories</th>
<th>Carbs</th>
<th>Fat</th>
<th>Protein</th>
<th>Potassium</th>
<th>Sugar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peanut butter - Reduced sodium, 2 tbsp</td>
<td>203</td>
<td>7</td>
<td>16</td>
<td>8</td>
<td>239</td>
<td>3</td>
</tr>
<tr>
<td>Parkay - Margarine, 1 Tbsp</td>
<td>70</td>
<td>0</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Woolworths - Multigrain Sandwich Bread, 2 slices (59g)</td>
<td>140</td>
<td>24</td>
<td>2</td>
<td>6</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>**Add Food</td>
<td>Quick Tools**</td>
<td>413</td>
<td>31</td>
<td>25</td>
<td>14</td>
<td>239</td>
</tr>
</tbody>
</table>

### Dinner

<table>
<thead>
<tr>
<th></th>
<th>Calories</th>
<th>Carbs</th>
<th>Fat</th>
<th>Protein</th>
<th>Potassium</th>
<th>Sugar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spaghetti - Whole-wheat, cooked, 2 cup</td>
<td>347</td>
<td>74</td>
<td>2</td>
<td>15</td>
<td>123</td>
<td>2</td>
</tr>
<tr>
<td>Beef - Lean Mince, 150 g</td>
<td>288</td>
<td>0</td>
<td>20</td>
<td>29</td>
<td>434</td>
<td>0</td>
</tr>
<tr>
<td>Kraft Mozzarella - Cheese, 2 oz</td>
<td>200</td>
<td>0</td>
<td>16</td>
<td>14</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>**Add Food</td>
<td>Quick Tools**</td>
<td>835</td>
<td>74</td>
<td>38</td>
<td>58</td>
<td>557</td>
</tr>
</tbody>
</table>

### Morning Tea

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<table>
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</tbody>
</table>

### Afternoon Tea

<p>| | | | | | | |</p>
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</tr>
</tbody>
</table>

#### 6.4.11 Nutritional analysis

The nutritional analysis indicates that this approach gives us a macronutrient profile that is about half carbohydrates (i.e. less than the 60% that is typical in western countries today). Using fruit instead of vegetables however gives us a much lower score on the vitamins and minerals and the protein score is relatively low.

The major concern with this approach is the glycemic load at 160 and the nearly 300g of carbohydrates per day. This approach would present a problem for a diabetic trying to manage their blood glucose and would likely promote diabetes over time for a lot of people.
6.5 Scenario 4 – Athlete or a metabolically healthy person

This scenario is designed for an athlete who may want to consume more carbohydrates before or after an intense workout while still maximising nutrient density.

Paleo nutrition guru Robb Wolf says that he is a fan of the low carbohydrate ketogenic dietary approach combined with intermittent fasting, however the people that seem to do it are not the overweight sedentary office workers who might benefit most from it, but rather the people who are doing intense workouts combined with intermittent fasting and then trying to cram massive amounts of high fat calories into their compressed intermittent fasting eating window.89

If you’ve got weight to lose, have elevated blood glucose and / or are not doing a lot of intense exercise then carbohydrate loading is probably not for you. However some people who are doing a lot of exercise may benefit from a greater amount of carbohydrates during recovery as well replenishing glycogen stores before a competition where burst power is required.

Ben Greenfield recommends that athletes stay low carb (i.e. 10% of calories) most of the time and then have a higher carbohydrate meal after workouts (i.e. 30% of calories). This is conceptually similar to John Kiefer’s Carb Backloading90 or Carb Nite91 which is designed for physique competitors wanting the benefits of ketogenic diet without burning themselves into the ground or stalling. Most of us though with day jobs who do a bit of exercise don’t have this problem.

90 http://carbbackloading.com
91 http://carbnite.com/
This approach emphasises nutritional density per 100g (40% weighting), with a lesser weighting towards the insulinogenic properties (25%) and nutrient density per calorie (15%).

<table>
<thead>
<tr>
<th>nutrient density / calorie</th>
<th>fibre / calorie</th>
<th>nutrient density / $</th>
<th>nutrient density / weight</th>
<th>insulin (%)</th>
<th>calories / 100g</th>
<th>$ / calorie</th>
</tr>
</thead>
<tbody>
<tr>
<td>15%</td>
<td>10%</td>
<td>10%</td>
<td>30%</td>
<td>20%</td>
<td>5%</td>
<td>10%</td>
</tr>
</tbody>
</table>

The prioritised food rankings are shown below. Again Rich Froning’s favourite calorie and nutrient dense peanut butter rates well along with a wide range of nutrient dense nuts and seeds. Vegetables do well.

A number of grain based foods make it in at the bottom of the list, such as oats. Organ meats, as always, ranks highly.

It’s interesting to note that paleo darling bacon ranks as the first non-seafood meat, whereas it ranked further down the list in the other approaches which prioritised lower calorie density. Living on bacon rather than vegetables may not be ideal if you’re primary aim is weight loss.

6.5.1 Nuts, seeds and legumes
- peanut butter
- sunflower seeds
- peanuts
- brazil nuts
- pumpkin seeds
- pistachio nuts
- pecans
- cashews
- almonds
- pine nuts
- macadamia nuts
- lentils
- kidney beans
- mung beans
- chick peas
- coconut meat

6.5.2 Vegetables and spices
- spinach
- mushrooms
- chives
- coriander
- chard
- turnip greens
- rosemary
- spirulina

6.5.3 Dairy and egg
- egg yolk
- whole egg
- cheese
- milk

6.5.4 Animal products
- organ meats (Liver, heart, giblets)
- sardine
- oyster
- anchovy
- cod
- herring
- bacon
- oyster
- chorizo
- mussel
- trout
- salmon

6.5.5 Fats and oils
- olive oil
- coconut oil
- butter

6.5.6 Fruit
- avocado
- olive
- raspberries
- blackberries
- oranges
- banana
- dates
- strawberries

6.5.7 Grains
- tortilla
- oats
- white bread
- multi grain bread
- croissants
- oat bran muffins
- rice
6.5.8 Daily diet

A possible daily meal plan using the highest ranking foods and using this weighting is shown below. For breakfast we have bacon with spinach and eggs, a salad with tuna for lunch, salmon and veggies for dinner with nuts for snacks. I’ve used full cream milk in the coffees to get the carbs up, although it doesn’t rank well on the nutrient density compared to the other options and not everyone who follows the paleo template will want to drink milk.

<table>
<thead>
<tr>
<th></th>
<th>Calories</th>
<th>Carbs</th>
<th>Fat</th>
<th>Protein</th>
<th>Potass</th>
<th>Sugar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coffee - Brewed from grounds, 1 oz/s</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>14</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Eggs - Fried (whole egg), 2 large</td>
<td>165</td>
<td>1</td>
<td>14</td>
<td>13</td>
<td>135</td>
<td>1</td>
</tr>
<tr>
<td>Milk - Whole, 2 25% milkfat, 1 cup</td>
<td>145</td>
<td>11</td>
<td>6</td>
<td>8</td>
<td>348</td>
<td>13</td>
</tr>
<tr>
<td>Bread - Oatmeal, toasted, 2 slice</td>
<td>146</td>
<td>26</td>
<td>2</td>
<td>5</td>
<td>77</td>
<td>4</td>
</tr>
<tr>
<td>Spinach - Cooked, boiled, drained, with salt, 2 cup</td>
<td>83</td>
<td>14</td>
<td>1</td>
<td>11</td>
<td>1,678</td>
<td>2</td>
</tr>
<tr>
<td>Crostini - Bacon, 3 Slices (60 gr)</td>
<td>332</td>
<td>30</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Add Food | Quick Tools | 850 | 52 | 56 | 45 | 2,253 | 20 |

6.5.9 Nutritional analysis

This dietary approach gives a good nutrient and protein score that is similar to the low carb and the low calorie density approaches. However the glycemic load is significantly increased compared to scenarios 1 and 2 with 25% of calories coming from carbohydrates.
This approach may be useful for an athlete preparing for a power event where they need additional explosive power, however in the long term there is the risk that it would place additional load on their pancreas and that may lead to diabetes.

It may also be beneficial for an athlete to train with a low carb approach to build their mitochondria and then occasionally ‘carb up’ with this moderate carb approach.

Tim Noakes has stated that he believes that no athlete needs more than 200g of carbohydrates per day. Minimising carbs will minimise inflammation and hence minimise injuries and maximise an athlete’s longevity rather than simply improving short term performance.

6.6 Limitations

The prioritised lists of foods in this section are based on the analysis of the raw data and do not account for anti-nutrients and toxins or foods that you personally have an issue with.

When looking down the list of foods to pick ideal foods you should also consider foods that contain toxins and anti-nutrients and foods that you personally may or may not tolerate well. Useful resources to help you refine your choices include Dave Asprey’s *Bulletproof Diet* book,92 Chris Kresser’s *Personal Paleo Code*93 or Paul Jaminet’s *Perfect Health Diet*.94

93 http://my.chriskresser.com/books/tpc/
94 http://perfecthealthdiet.com/
Many of us are delicate petals in our own way including the following considerations:

- Some people choose to avoid peanuts or lentils because they are legumes or contain lectins.
- Many people will avoid oats and bread because they are grain based and lead to leaky gut.
- Many people avoid nuts because they find it hard to stop eating them.
- Many people find they do better if they limit the casein or lactose proteins from dairy.
- Many people avoid tofu and soy due to their oestrogenic properties.

Buying organic is another consideration and people will need to endeavour to buy foods that do not contain pesticides, depending on their goals, health and budget. See David Suzuki’s Dirty Dozen (foods that should ideally be organic) and Clean Fifteen (foods that don’t need to be organic).

The issue of genetic modified foods is also something you may want to consider for yourself.

If you can afford it, grass fed and wild caught contain less toxins and more good fats and taste great too.

6.7 Cheat sheets

I’ve developed a range of cheat sheets that summarises the learnings for each scenario outlined in this section that you can stick on your fridge as a reminder of ideal food choices or use for inspiration for your next shopping expedition. They can be downloaded here.

6.8 Meal rankings

Similar to analysis of the various dietary approaches I have also undertaken an analysis of more than one hundred different meals to identify the most nutritious options for my family and hopefully a wider audience of people trying to optimise nutrition and minimise insulin.

The meals in the spreadsheet are ranked based on the following properties of the meals, meaning the meals at the top of the list should generally be the best for you:

1. proportion of insulinogenic calories.
2. vitamin and mineral sufficiency score
3. protein sufficiency score.

More detail on each of these recipes can be found using the hyperlink on the right hand side of the spreadsheet.

You can further refine the prioritisation by filtering based on net carbs, protein, nutritional completeness based on your preference sand individual goals.

You can download the list of meals here and find out more details on the background of the ranking system here.

6.9 Summary

- The multi criteria weighting enables us to prioritise food selection based on different goals.

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- Someone wanting to lose weight can use the ranking system to prioritise low calorie density, high fibre, low carbohydrate foods as per scenario 1.

- A diabetic can follow scenario 2 to prioritise for foods that will minimise insulin load while still obtaining good levels of nutrition.

- Prioritising cost can over nutrition as per scenario 3 leads to a grain-based high glycemic load diet which may lead to diabetes and should ideally be avoided.

- The ranking system can also be used to prioritise high nutrient foods for athletes as per scenario 4 wanting to replenish glycogen stores with a bit more carbohydrate before or after a workout.