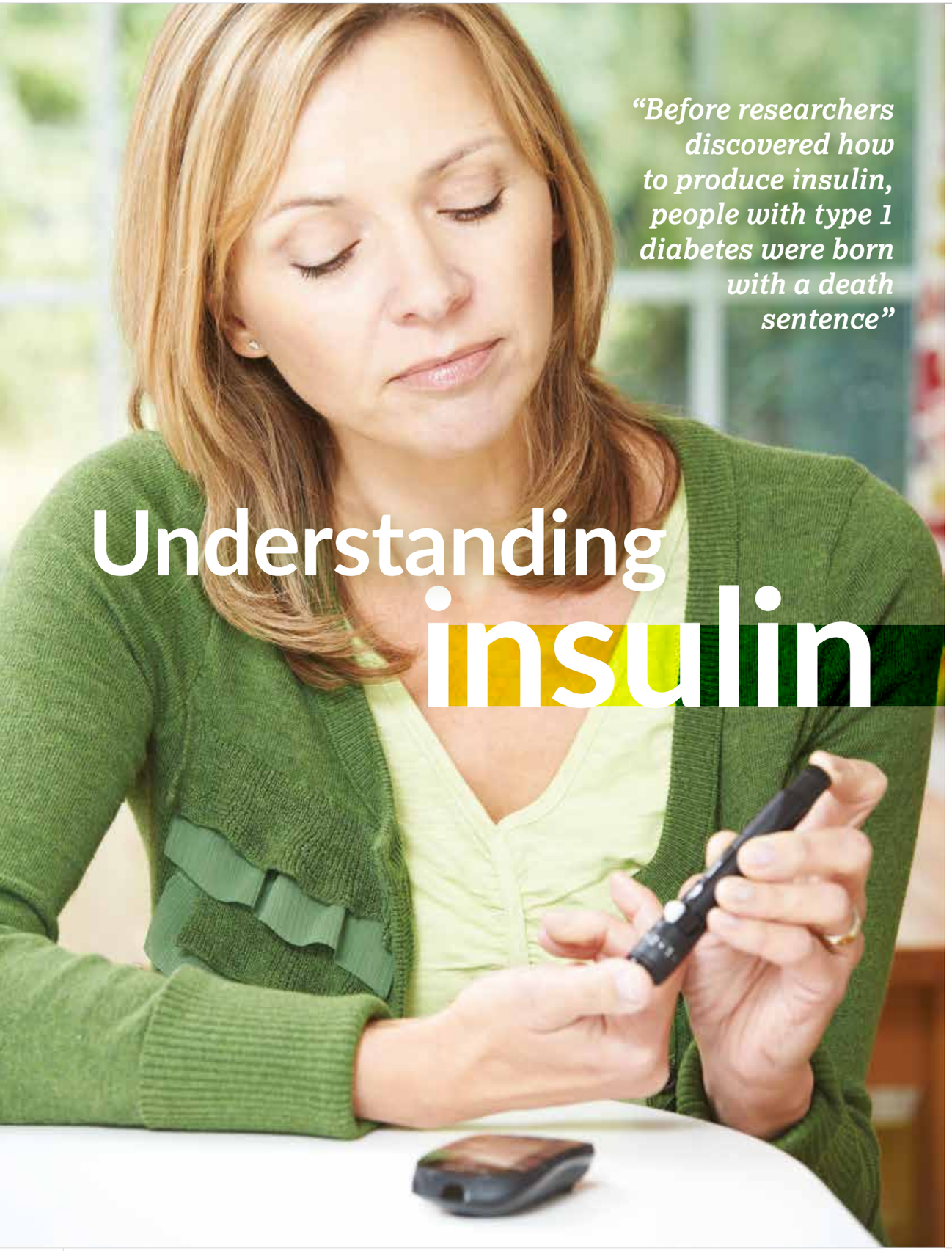

Understanding insulin

Insulin is one of the most important hormones in the human body, yet it's a hormone most people don't really understand. Registered dietitian Linia Patel gives her perspective and advice.

Insulin is produced in the pancreas by the islets of Langerhans and it regulates the amount of glucose in the blood by allowing your body to use glucose for energy or to store glucose for future use.

Glucose is a simple sugar that provides the body with its primary source of energy. Glucose in the body comes from digesting carbohydrates (such as rice, pasta, grains or vegetables and fruit). Glucose is carried to the cells through the bloodstream. The human body needs blood glucose (blood sugar) maintained in a very narrow range. In Europe, blood sugar is measured using millimoles per litre. A 'normal' blood glucose level comes in at around 4-7mmol/L.[1]

Insulin secretion

Insulin's main job is to signal to the liver, muscles and fat tissues to take up glucose from the blood and store it as glycogen (the body's carbohydrate store). As soon as the glucose level in the blood drops to normal, insulin release slows or stops. Although there is always a low level of insulin secreted by the pancreas, the amount secreted into the blood increases as the blood glucose level in the blood rises. Similarly, as blood glucose falls, the amount of insulin secreted by the pancreas goes down. If the blood drops down too low (such as between meals and during exercise) an antagonistic hormone called glucagon is released which does the opposite of insulin, stimulating the breakdown of glycogen and release of glucose to push up blood sugar levels.

Insulin also regulates how the body uses and stores glucose and, subsequently, fat. Once carbohydrate has been consumed and is digested into glucose, insulin has three options. The first option is to use blood glucose for metabolic energy. However, if your cells do not need fuel and your blood glucose levels rise above 7mmol/L, insulin signals to the liver to begin synthesising glycogen as its second option. The body has limited ability to store glycogen; hence, once glycogen stores are full, insulin triggers its third option, which is the synthesis of fat from the absorbed blood glucose. Insulin also increases the transport of amino acids from the blood into the cells, therefore stimulating protein synthesis.[1, 2]

Why is insulin so important?

Like all hormones, insulin has an optimal level and important functions. Without enough insulin, blood glucose builds up in the blood and the cells are starved of their energy source. A lack of insulin or an inability to adequately respond to insulin can each lead to the development of the symptoms of diabetes.

Type 1 and 2 diabetes

Type 1 diabetes is an autoimmune disorder usually diagnosed in childhood. In type 1 diabetes, the cells in the pancreas that make insulin get destroyed. Before researchers discovered how to produce insulin, people who suffered from type 1 diabetes were born with a death sentence. The most effective treatment was to put them on a very strict, minimal carbohydrate diet, which would add a couple more years to a person's life but definitely wouldn't save them.[3]

In 1921, Canadian scientists Frederick Banting and Charles Best successfully purified insulin from a dog's pancreas. Over the next decades, researchers continued to improve insulin. Insulin from cattle and pigs was used for many years to treat diabetes and saved millions of lives, but it wasn't perfect, as it caused allergic reactions in many patients. In the early 1980s, biotechnology revolutionised insulin synthesis. Today, insulin now comes in many forms, from regular human insulin, which is identical to what the body produces on its own, to rapid and long-acting insulins. Insulin is still the primary therapy used to treat type 1 diabetes. Type 1 diabetics usually inject themselves with different types of insulin three or four times a day. The treatment for type 2 diabetes, however, differs.

Type 2 diabetes usually develops gradually over a number of years. The condition is also referred to as insulin resistance. Depending on their level of insulin resistance, people with type 2 diabetes may also need to take insulin injections to manage their blood sugar level; however, it can also be managed with a good diet and a healthy lifestyle[4].

Insulin resistance: The hallmark of metabolic syndrome

Eating the wrong type or too much carbohydrate will lead to large amounts of insulin being secreted. Continual elevation of insulin leads to large amounts of fat gain (deposited centrally). The more fat tissue you have, the harder it is for your body to use insulin, which ultimately leads to insulin resistance.

Insulin resistance is a condition in which the cells of the body become resistant to the hormone. It is also now recognised as a strong predictor of disease in adults. For example, it precedes the development of type 2 diabetes and is associated with an increase of developing heart disease, as well as other medical conditions such as fatty liver and reproductive abnormalities.

Interestingly, some recent evidence suggests that whatever organ becomes insulin resistant ends up manifesting its own chronic metabolic disease. For example, if you have insulin resistance of the brain, you end up with Alzheimer's disease.[5]

Keeping sensitive

You need insulin but the trick is to learn how to balance the fat storage effects against the anabolic effects in muscle tissue. This can be done by increasing insulin sensitivity in the muscle, while decreasing insulin sensitivity in the fat cells. Controlling the insulin releases during the day is important for long-term sensitivity.

What keeps insulin sensitivity high?

1. The effect of diet

There is a strong body of evidence that shows choosing carbohydrate-dense foods that are low on the glycaemic index may also have beneficial effects, especially when combined with a reduction in calories and regular exercise. It has also been postulated that a plant-based diet containing significant levels of phytochemicals may effectively prevent insulin resistance.[6, 7]

Research also indicates that a diet high in total (>40% total energy) trans and saturated fat may promote insulin resistance. Replacing saturated fat with polyunsaturated (particularly omega-3 fats) or monounsaturated fat may improve insulin sensitivity, but only if total fat intake also is controlled[6].

There is currently some evidence that getting enough vitamin D may reduce one's risk of developing insulin resistance. A recent trial

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involving 2,000 adults at high risk of type 2 diabetes were either given 2,000 IU of vitamin D per day or a placebo. They found that vitamin D supplementation significantly improved insulin sensitivity and therefore helped control the rise of blood sugar in comparison with the placebo group. While there is a large body of evidence, there is a need to do a large intervention study to fully understand the role of vitamin D and the action of insulin[8].

2. The effect of exercise

There is substantial evidence showing improved insulin sensitivity after exercise, both with and independent of weight loss. There's debate about the best exercise prescription to maximise insulin sensitivity in different populations; both regular aerobic exercise and resistance training seem to confer beneficial results.

A landmark study by Defrenzo *et al* showed that a simple exercise intervention like walking had a significant impact on insulin sensitivity. In this study, the intervention group participated in a walking programme, although participants were gradually (at the end of four weeks) exercising at a relatively high level of intensity (80-85% of maximum heart rate) for 50-60 minutes per day, five days a week. Level of fitness, as measured by aerobic capacity, was strongly correlated with insulin sensitivity in this study group.[9]

A randomised 12-week trial designed to examine the effect of exercise (aerobic and resistance) or exercise combined with moderate caloric restriction on insulin resistance showed interesting results. Despite a greater rate of weight loss in the caloric restriction and exercise group (7.4% of initial bodyweight), this didn't lead to any greater improvement in insulin resistance. A reason for this may be the increased loss of lean muscle mass.[10]

The importance of sleep

Research has also shown that sleep deprivation and insulin resistance may be linked. A study comparing the impact of sleep deprivation or a high-fat diet on insulin resistance yielded interesting results. The researchers found that the night of sleep deprivation decreased insulin sensitivity by 33%, while six months of a high-fat diet decreased it by 21%.[11] ***fp***

BIOGRAPHY

Linia Patel has a BSc degree in biochemistry and physiology. Since graduating in 2006, Linia has taken up various leading roles in performance nutrition and public health. **liniapatel.com**

"Substantial evidence shows improved insulin sensitivity after exercise, both with and independent of weight loss"

10 tips to improve insulin resistance

1. 
If you are overweight, lose some weight.

2. 
Exercise for five hours a week.

3. 
Look after your muscle mass.

4. 
Choose slow-release carbohydrates that are high in fibre.

5. 
Keep your refined carbohydrate intake in check.

6. 
Eat a diet rich in monounsaturated fat from sources such as extra virgin olive oil, nuts and avocado.

7. 
Eat your five-a-day or more. Choose a variety of vegetables and fruit that covers a full spectrum of colours.

8. 
Eat fish frequently. Opt for oily fish, such as wild salmon and sardines.

9. 
Get sufficient vitamin D – go on a sunny holiday or consider supplementation.

10. 
Sleep for seven or eight hours per night.

My day on a plate

Your food diaries under the microscope

Terry Gibbs is head of commercial development at FitPro. He exercises every day and tends to eat at the same time each day to keep his body feeling balanced. Typically, his calorie usage during his daily exercise session is between 450 and 700 calories. He runs 200m and 400m as his chosen sport.

06:10

Breakfast is 80g of fruit and fibre with half a banana and skimmed milk, plus a cup of tea (quite a big mug!) with a dash of skimmed milk.

11:00

I have a piece of fruit, typically a pear, banana or berries. I avoid apples as they bloat me.

13:00

I have one and a half rounds of ham sandwich. I don't like butter, so it's simply three slices of wholemeal or seeded bread and one and a half slices of lean ham.

15:00

I have more fruit. Alternatively, I'll choose 40g of mixed nuts. During the day, I'll have three teas with semi-skimmed milk. I feel fine all day. If I get hungry, I reach for nuts or fruit.

19:00

At the track I feel good during the warm-up. My session is hard, with 12 pulsating 300m runs with a 100m walk recovery. 'Pulsating' means the odd-numbered runs are at a lower tempo (HR at about 75%) and the even-numbered runs are much faster (HR hits maximum). I use 600+ calories.

20:30

As it's a track day, I eat my dinner a little later. Today it's 600g of roast chicken (no skin), 100g of broccoli, 100g of cauliflower and 100g of carrots (steamed as I like them crunchy!), plus 300g of oven-roasted potatoes. After dinner, I have an instant coffee (again quite a large mug) with a dash of skimmed milk.

22:30

Time for bed.

Linia's verdict

Resident dietitian Linia Patel looks for a more varied diet.

Terry lives an active lifestyle and eats a diet that matches his energy expenditure (+/- 2,800kcal per day) which is good. He hits his five-a-day and opts for wholegrain carbohydrates, which is positive. However, Terry needs to make significant changes.

The first recommendation is that Terry adds variety to his diet. Varied diet = more nutrients. Terry's daily ham sandwich needs to change! Regular intake of processed meats is considered unhealthy. Processed meat like ham is high in sodium and nitrates and has been linked to an increased risk of numerous health problems, such as heart disease and type 2 diabetes. The World Cancer Research Fund (WCRF) recently reviewed over 7,000 studies on all aspects of diet and cancer risk.[1] The report found that every 50g of processed meat eaten daily increases your risk of colorectal cancer by an average of 21%. While scientists are unsure of exact mechanisms, Terry is better choosing fish, skinless chicken, lean red meat or vegetarian sources of protein instead. Adding avocado or hummus and salad to his sandwiches would further boost the nutrient quality of his lunch. Alternatively, Terry could bring in leftovers from dinner (i.e., a mixed and balanced meal) or lentil-based soup and oatcakes.

For his current activity levels, dietary analysis shows that Terry consumes 3.4g/kg BW/day in protein, which is higher than recommended. There is little justification for protein intakes in excess of 2.0g/kg BW/day. Daily protein needs depend on age, body composition and activity levels; however, with an intake of 1.5-1.8g/kg BW/day, he would still protect his muscle mass and recover and adapt from exercise sessions.

Just as important as the amount and type of protein Terry eats is *when* he should eat it. Terry's current protein distribution is not ideal, as the majority of his protein intake comes in the evening. A study recently published in the *Journal of Nutrition*[2] found that muscle protein synthesis was 25% higher when protein was evenly distributed across breakfast, lunch and dinner, compared with a more typical pattern when most protein was consumed at the evening meal, even when total protein intake was the same. To boost protein intake at breakfast, Terry could add nuts to his cereal, use a higher protein Greek yogurt instead of milk or bring further variety in and opt for higher protein breakfasts like eggs, smoked salmon or beans on toast.

The general consensus is that those who are acclimatised to regular exercise experience less muscle protein breakdown. However, protein needs are greater during intense training and protein ingestion after exercise, when muscle is most sensitive to nutrient intake, will boost muscle protein synthesis and recovery.[3] Terry would therefore benefit from consuming a rapidly absorbed, protein-rich (+/- 20g protein) snack as soon as possible after training. This could be chocolate milk or a smoothie made with fruit, yogurt/milk and whey protein, or a protein bar or egg and watercress sandwich.

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