

100% fruit juice and metabolic health

The consumption of whole fruits and vegetables is associated with a reduced risk of type 2 diabetes mellitus (T2DM). Yet 100% fruit juices which contain the full range of nutrients and bioactives found in whole fruits, although not the fibre, are often cited as a likely cause or promoter of T2DM. Why should this be and what evidence exists to support the opinion?

Fruit juices and glycaemic control

Four meta-analyses on fruit juice consumption and the risk of T2DM onset are available in the literature. One meta-analysis of four cohorts of consumers showed that the consumption of fruit juices with added sugars was significantly associated with an increased risk of T2DM (RR = 1.28; $p = 0.02$) while the consumption of 100% fruit juices was not related (RR = 1.03, $p = 0.62$)¹.

A second meta-analysis examined fasting blood glucose and insulin levels in 12 randomised controlled trials involving more than 400 participants who were either obese or had risk factors for diabetes or cardiovascular disease². In half of these studies, fruit juice intakes were 400g per day or more. The overall results showed that consumption of fruit juices had no significant effect on fasting glycaemia levels and insulin levels. Subgroup analysis revealed that the findings were unaffected by baseline glucose concentration, duration of study, type of fruit juice, glycaemic index of fruit juice and quality of the study suggesting a consistent effect across the 'at risk' population.

A third meta-analysis³ evaluated the effects of the consumption of sugar-sweetened soft drinks (17 studies), artificially sweetened soft drinks (10 studies) and 100% fruit juices or fruit juices without added sugars (13 studies). It emerged that the high consumption of all these products, at intakes of more than 250ml/day, led to a significant increase in the risk of T2DM. With regard to fruit juices, the result only became statistically significant (RR = 1.07; $p > 0.05$) after adjusting for a set of confounding factors, including adiposity. Therefore, the authors suggested that the results for fruit juices (unlike for sugary beverages) should be interpreted with caution.

A fourth meta-analysis of randomised controlled trials included 18 studies specifically on 100% fruit juice. The findings clearly showed that consumption of fruit juice had no significant effect on fasting blood glucose, fasting blood insulin, HOMA-IR (a measure of insulin sensitivity) or HbA1c (indicating long-term blood glucose control)

These findings are consistent with the conclusions from some observational studies suggesting that consumption of 100% fruit juice is not associated with increased risk of diabetes.

Fruit and vegetable consumption and T2DM

A meta-analysis⁴ including 13 cohorts with 434,342 participants and 24,013 T2DM events (11-year follow-up) reported that a high intake of combined fruit and green leafy vegetables was associated with a significantly reduced risk of diabetes. A linear-type dose-response association was seen. This, and evidence from other cohort studies and meta-analyses of these studies identify a trend, not always statistically significant, towards risk reduction both through the consumption of fruit and vegetables.

Specific whole fruits, including blueberries, grapes and raisins, prunes, apples and pears, bananas and grapefruit led to a significant reduction of T2DM, while the consumption of melons was associated with a significant increase in risk.⁵

The Nurses' Health Study II⁶, conducted on 13,475 women on the risk of gestational diabetes mellitus, observed a trend for T2DM risk reduction with higher intakes of fruits but this was not statistically significant (RR = 0.93; p = 0.76). An inverse association with apple consumption just achieved significance and may simply be a random result (RR = 0.80; p = 0.045). Results from an experimental study on 152 patients with T2DM, reported that higher intake of fruit with a low glycaemic index was associated with a significant reduction in HbA1c (R = -0.206; p = 0.011), with marked differences between the various types of fruit.⁷ A reason for the surprisingly weak findings for whole fruit may be that individual fruits vary considerably in their nutrient density, glycaemic load, and bioactive compounds.

Findings relating to plant flavonoids are more consistent. For example, one study found that intakes of naringenin and hesperetin (found in oranges and orange juice) were linked with a lower risk of cerebrovascular disease⁸. A meta-analysis of randomised controlled trials examining health effects of genistein (found in chick peas and soya) reported that it significantly improved glucose control and insulin sensitivity in postmenopausal women⁹.

Glycaemic Index and glycaemic load

Very high fructose diets (>100g/day) tend to promote increases in the glycaemic and insulin response to glucose loading, as well as fasting blood glucose and hepatic insulin resistance¹⁰. In contrast, experimental evidence¹¹ indicates that small quantities of fructose (<10g in a meal) reduce post-prandial glycaemia and glycaemic response to glucose loading. Further evaluation of the relationship between sugars, specifically fructose, on health suggest that overconsumption of energy is the driving factor in issues such as fatty liver, obesity and poor glycaemic control¹². In any case, estimates for fructose intakes in Europe are in the region of 40-50g per day^{13,14} which is well below those levels that may cause concern.

It is likely that the consumption of fructose in moderation promotes improved glucose tolerance by triggering net liver and muscle uptake of glucose. In addition, fructose absorption is not dependent on insulin production. A portion (200ml) of 100% fruit juice contains between 1 and 15g of fructose, depending on the type of fruit used. As per European law, 100% fruit juice never contains added sugars.

Conclusion

Consumption of fruit and vegetables is associated with a reduced risk of type 2 diabetes mellitus while consumption of 100% fruit juice appears to have no impact on diabetes risk or glycaemic control based on several high quality meta-analyses.

Small quantities of fructose (<10g in a meal) reduce post-prandial glycaemia and the glycaemic response to glucose loading. Based on the available studies, the consumption of 100% fruit juices, as part of an isoenergetic diet, is not associated with an increased risk of type 2 diabetes mellitus.

References

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