

Dietary strategies for the prevention of pre-diabetes

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1. The continuing rise in the prevalence of Type 2 diabetes and the burden this places on individuals and society has brought a new impetus to develop strategies for primary prevention. Diet is an important risk factor and dietary change is likely to be critical to primary prevention.
2. Observational studies have suggested that a number of dietary components may modulate risk. The WHO Technical Report 916⁽¹⁾ in 2003, based predominately though not exclusively, on observational data, pointed to excess weight as a 'convincing' factor in the aetiology of diabetes, with saturated fat and fibre as 'probably' increasing or decreasing risk respectively. Evidence since then has added support to these risk factors. See for example the review by Steyn *et al.* (2004) on the role of diet in type 2 diabetes ⁽²⁾.
3. Other risk factors were identified as 'possibly' linked to the risk of diabetes. Here the protective role of low GI foods has strengthened, though evidence is still mixed (perhaps in part because of poor dietary characterisation) ^(3,4). The protective role of long chain n-3 fatty acids (or fish) remains plausible but inconclusive. Recent analyses from two large cohorts, in USA ⁽⁵⁾ and EPIC Norfolk ⁽⁶⁾, have found no evidence of an association after adjustment for other dietary factors. Evidence for a beneficial effect of wholegrain foods is limited to some large observational studies of which many are confounded by poor segregation of wholegrain from fibre in the dietary assessment ⁽⁷⁾.
4. Other factors were identified as 'possibly' increasing risk. Few new studies report total fat as a specific risk factor, though the evidence tends to support an association between higher intakes of saturated fatty acids and insulin resistance ⁽⁸⁾. Limited evidence suggests that high intakes of trans fatty acids may aggravate insulin resistance ^(9,10).
5. There is emerging evidence that a high protein intake may be associated with increased risk. Two recent systematic reviews support an association between high meat intake, especially processed meat, and an increased risk of diabetes, though the mechanism is unclear and the association may be confounded by other dietary and lifestyle habits ^(11,12).
6. There are sporadic reports of protective associations between specific micronutrients and the risk of diabetes, especially calcium, Vitamins D and E, magnesium and chromium, but the case is unproven, especially in the context of primary prevention ^(13,14,15).
7. Dietary intervention studies focused on the manipulation of individual nutrients have generally provided less convincing data on the link to diabetes or more usually, insulin sensitivity. The number of large, high quality studies is severely limited and there are methodological limitations to this approach which include: (i) Difficulties in designing double-blind studies (ii) Consent and screening may constitute an intervention, (iii) Contamination of control group by generic

nutrition messages, (iv) Difficulties in manipulating a single component of the diet vs. challenge of complex interventions, (v) Compliance may be poor and difficult to measure (vi) Reliance on intermediary risk biomarkers as outcome measures (vii) Inter-individual variability in response may be large, with implications for sample size and power.

8. In my research programme over the last 10 years we have examined the impact of long chain n-3 PUFA⁽¹⁶⁾, n6:n3 ratio⁽¹⁷⁾, SFA⁽¹⁸⁾, high MUFA⁽¹⁸⁾, wholegrain (fibre)⁽¹⁹⁾, GI^(18,20), and protein⁽²⁰⁾, in large, highly controlled, explanatory dietary intervention studies. In most cases there has been no significant change in insulin sensitivity, measured using techniques ranging from fasting indices to intravenous glucose tolerance tests.
9. The limited impact of tightly controlled nutrient-based interventions contrasts with a 'whole-diet approach', especially where this includes a focus on achieving and maintaining weight-loss. Studies including the Diabetes Prevention programme and Finnish Diabetes Prevention trial have shown a marked reduction in the incidence of type 2 diabetes with intensive professional-led lifestyle counselling⁽²¹⁾. Secondary analyses suggest the effect is driven by weight loss, with additional contributions from reductions in saturated fatty acids and increases in fibre.
10. Achieving weight loss usually requires a significant reduction in energy intake. A 500 kcal/d deficit translates to a weight loss of approximately 0.5 kg/week. A number of strategies have been shown to be effective including lifestyle interventions, pharmacotherapy and bariatric surgery (see NICE guidance on treatment of obesity²²). Increases in physical activity bring some additional benefits in terms of improved fitness and consequent reductions in diabetes risk, but dietary intervention is the cornerstone for effective weight loss in most population groups.
11. The principal research challenge is now focused on how to turn reductions in energy intake into a sustainable dietary plan, with a strong focus on adherence. Low fat, low carbohydrate, low GI or high protein diets can all be successful strategies to reduce total energy intake in the short term (<1 year), through a combination of biological and behavioural mechanisms, but weight loss is usually attenuated thereafter⁽²³⁾. Ongoing support from health professionals or other trained staff has been associated with improved weight-loss maintenance. The LOOK Ahead trial is showing promising results 5 years on and includes the use of liquid meal replacements and structured meal plans⁽²⁴⁾.
12. In everyday life, most people do not count calories, or fat or carbohydrate, nor wish to do so. There is growing interest in dietary advice on changes in specific food groups, particularly sugar-sweetened beverages and fast food. Other 'dietary behaviours' of interest include portion control, eating frequency, meal patterns, 'unconscious eating' and eating in the absence of hunger but research evidence is at present very limited, especially for primary prevention⁽²⁵⁾.
13. The impact of sugar-sweetened beverages has received particular attention in recent years. Observational studies show a trend towards a positive association with weight gain/obesity^(26,27). This is supported by mechanistic data but there are few intervention studies and little strong evidence of improved weight control following interventions targeted at reductions in sugar-sweetened beverages⁽²⁸⁾. Sporadic reports suggest a specific association with diabetes risk⁽²⁹⁾.
14. Experimental studies have consistently shown that the provision of larger portions of food is associated with increased energy intake at that eating occasion

and incomplete compensation at subsequent eating occasions ⁽³⁰⁾, approximating to an extra 0.5MJ/d for every 2.5 MJ increase in energy provided. There is scant evidence on the impact on energy intake of smaller portions. Moreover, given the known asymmetry of appetite it is not possible to extrapolate to infer whether a reduction in portion size will be an effective strategy for weight loss and little is known of the biological or behavioural mechanisms through which portion size impacts on innate appetite control.

15. One of the greatest challenges lies in implementing dietary change. The weight loss achieved in intensive research studies is not easily replicated at scale and resource constraints mean that individual-level interventions are unlikely to be a sustainable option, particularly for primary prevention. Accordingly the emphasis is shifting to population-level solutions to change the environment in which we live in order to halt the rise in diabetes and other chronic diseases. This effort is aided by the synergy between the dietary strategies to prevent obesity, vascular disease, diabetes and diet-dependent cancers.
16. Population level interventions at present include consumer information (through campaigns and improved labelling), reformulation (and new product innovation) especially to reduce fat, sugar and salt, restrictions on marketing, especially to children and some restrictions on access and availability of some food/drink products, especially in schools and on the 'school fringe'. There is research interest in the potential for fiscal interventions to modify purchasing habits (and hence consumption), either through incentives for healthier foods⁽³¹⁾, or disincentives, especially linked to sugary drinks^(32,33).
17. The Foresight report "Tackling Obesities:Future Choices"⁽³⁴⁾ set out a framework for public health action and this was used as a basis for the Healthy Weight, Healthy Lives strategy⁽³⁵⁾ developed by the previous government. Its focus was on weight control, but it provides a useful starting point for wider action to reduce the burden of chronic disease. There is perhaps an opportunity with the new government to make the case for continued investment and stronger cross-links between the prevention and management of obesity and the array of co-morbid conditions, including diabetes, to accelerate progress towards improving health.

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