

In conclusion, our validation suggests this approach will work reasonably well in identifying those with undiagnosed diabetes and HbA_{1c}/fasting glucose defined high risk. The implementation of this approach will have considerable workload implications for primary care, with up to half of those screened needing biochemical tests and 15% needing management of diabetes or high risk glycaemia. It is striking that, while the risk scores identify similar people, only half of those identified as high risk by one biochemical test would be considered to have high risk if assessed by the alternative test. There may be benefit in standardizing the approach in future.

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Competing interests

None declared.

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References

- 1 NICE. *Preventing Type 2 Diabetes: Risk Identification and Interventions for Individuals at High Risk*. Public Health Guidance 38. London: National Institute for Health and Clinical Excellence, 2012.
- 2 Gray LJ, Taub NA, Khunti K, Gardiner E, Hiles S, Webb DR *et al*. The Leicester Risk Assessment score for detecting undiagnosed Type 2 diabetes and impaired glucose regulation for use in a multi-ethnic UK setting. *Diabet Med* 2010; **27**: 887–895.
- 3 Griffin SJ, Little PS, Hales CN, Kinmonth AL, Wareham NJ. Diabetes risk score: towards earlier detection of type 2 diabetes in general practice. *Diabetes Metab Res Rev* 2000; **16**: 164–171.
- 4 Heianza Y, Arase Y, Fujihara K, Tsuji H, Saito K, Hsieh S *et al*. Screening for pre-diabetes to predict future diabetes using various cut-off points for HbA_{1c} and impaired fasting glucose: the Toranomon Hospital Health Management Center Study 4 (TOPICS 4). *Diabet Med* 2012; **29**: e279–e285.

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Vegetarian diet in type 2 diabetes – improvement in quality of life, mood and eating behaviour

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Dietary intervention is one of the key components in Type 2 diabetes management [1]. Nevertheless, the major problem with hypocaloric diets is poor long-term patient adherence.

Vegetarian diets may be a useful strategy to encourage consumption of foods with a lower energy density [2,3].

The beneficial effect of a vegetarian diet on body weight, glycaemic control, blood lipids, insulin sensitivity and oxidative stress markers compared with a conventional diet has been previously demonstrated by us and others [2,3,4].

The psychological traits of eating behaviour (especially dietary restraint and disinhibition) seem to have an important role in the development of obesity [5]. In the course of our 24-week-randomized trial we studied quality of life, Beck depression score and eating behaviour in response to a vegetarian and a conventional diet.

The characteristics of the sample and the methods are described in detail elsewhere [2]. Briefly, 74 subjects with Type 2 diabetes treated by oral hypoglycaemic agents, both men (47%) and women (53%), were recruited. A 24-week, randomized, open, parallel design was used. The subjects were randomly assigned either into the vegetarian group ($n = 37$) or the control group ($n = 37$); those in the latter group received a conventional diet. Both diets were designed to be calorie-restricted (–500 kcal/day) based on the indirect calorimetry measurement [6]. The second 12 weeks of the diet were combined with aerobic exercise. All meals during the study were provided. Participants were examined at baseline, 12 weeks and 24 weeks. The study protocol was approved by the Institutional Ethics Committee.

The vegetarian diet (~60% of energy from carbohydrates, 15% protein and 25% fat) consisted of vegetables, grains, legumes, fruits and nuts. Animal products were limited to a maximum of one portion of low-fat yogurt a day. The conventional diabetic diet was administered according to the dietary guidelines of the Diabetes and Nutrition Study Group (DNSG) of the European Association for the Study of Diabetes (EASD) [7]. It contained 50% of energy from carbohydrates, 20% protein, less than 30% fat ($\leq 7\%$ saturated fat, less than 200 mg/day of cholesterol/day).

Participants were asked not to alter their exercise habits during the first 12 weeks. During weeks 12–24 they were prescribed an individualized exercise programme, described in detail previously [2].

Quality of life was assessed using two questionnaires: Obesity and Weight-Loss Quality of Life (OWLQOL) and Weight-Related Symptoms (WRSM) [8]. We used the Three-Factor Eating Questionnaire [9] to monitor changes in eating behaviour and the Beck Depression Inventory to screen for depressive symptoms [10].

For statistical analysis, we used a repeated-measures ANOVA model with between-subject and within-subject factors and interactions. Within each group, paired comparison *t*-tests were calculated to test whether the changes from baseline to 12 weeks, from baseline to 24 weeks and from 12 to 24 weeks were statistically significant.

The variables of quality of life, Beck Depression Inventory and Three-Factor Eating Questionnaire are shown in Fig. 1. Quality of life (the OWLQoL score) increased in

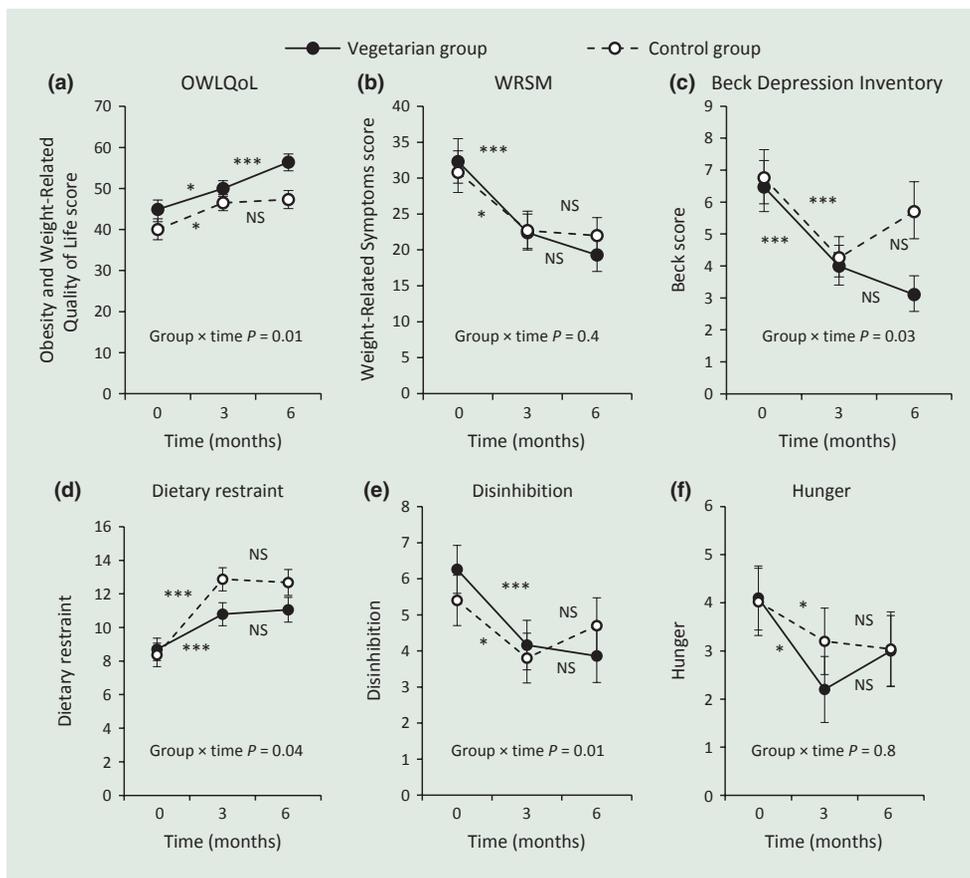


FIGURE 1 Quality of life, Beck Depression Inventory and Three-Factor Eating Questionnaire. Data are means \pm 95% confidence intervals. Significant changes from baseline to 12 weeks and from 12 to 24 weeks for within-group changes assessed by paired comparison *t*-tests are indicated: * $P < 0.05$, ** $P < 0.01$ and *** $P < 0.001$. Group \times time, *P*-value for the interaction between group (vegetarian and control group) and time (0, 12 and 24 weeks) assessed by repeated-measures ANOVA. NS, not significant

both groups comparably in weeks 12–0. It further increased only in the vegetarian group in weeks 24–12 (group \times time $P = 0.01$; Fig. 1a). The negative weight-related symptoms (WRSM) decreased in both groups in weeks 12–0 and remained reduced in weeks 24–12 (Fig. 1b). The Beck depression score decreased in both groups in weeks 12–0. The decrease was significant only in the vegetarian group from baseline to 24 weeks ($P < 0.001$; group \times time $P = 0.03$; Fig. 1c).

Dietary restraint increased in both groups in weeks 12–0, more in the control group, with no change in weeks 24–12 (group \times time $P = 0.04$; Fig. 1d). Disinhibition decreased in both groups in weeks 12–0, but the decrease was significant only in the vegetarian group from baseline to 24 weeks ($P < 0.001$; group \times time $P = 0.01$; Fig. 1e). Feelings of hunger decreased in both groups in weeks 12–0, with a trend toward a greater decrease in the vegetarian group, and no change in weeks 24–12 in either group (Fig. 1f).

Both hypocaloric diets elicited a positive effect on the quality of life and mood (although the average Beck Depression Inventory score of our patients did not reach the

threshold of depressive symptoms). The positive effect was greater with a vegetarian diet. The positive effect of a vegetarian diet on health-related quality of life has been shown previously [11]. It has been demonstrated that restriction in meat intake may improve mood [12] and that a vegetarian diet is associated with less negative emotions compared with omnivores [13]. The mechanism by which a vegetarian diet improves mood may partly be explained by the differences in the rate of neurotransmitter synthesis and receptor dynamics that has been reported in some studies [14].

The Three-Factor Eating Questionnaire revealed that the dietary restraint increased in both groups, suggesting an increase in the voluntary control over food intake with the aim to influence the body weight. The increase was greater in the control group, suggesting that the participants in the control group felt more constrained by their prescribed diet than did the participants in the vegetarian group. This in accordance with one study showing a less pronounced dietary restraint with a vegan compared with a conventional diet [15]. The decrease in disinhibition was significant only in the vegetarian group from baseline to 24 weeks, suggesting

that the participants in the vegetarian group were less likely to overeat; for example, in stressful situations. A trend toward a greater decrease in reported feelings of hunger in the vegetarian group suggests an easier adherence with a vegetarian diet in the long term.

Generally, the changes in the studied variables were more marked in response to the dietary interventions (in weeks 12–0) and did not change dramatically after the addition of exercise (in weeks 24–12). Differences between groups were significant despite large inter-individual variations in the studied variables.

In conclusion, a vegetarian diet led to a greater improvement in quality of life and mood. Patients consuming a vegetarian diet felt less constrained than those consuming the conventional diet. Disinhibition decreased with a vegetarian diet. The decrease in feelings of hunger tended to be greater in the vegetarian group. All these results suggest that a vegetarian diet is sustainable in the long term and may exhibit desired improvements not only in physical, but also in mental health of patients with Type 2 diabetes.

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Competing interests

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References

- 1 American Diabetes Association. Nutrition recommendations and interventions for diabetes: a position statement of the American Diabetes Association. *Diabetes Care* 2008; **31**: S61–S78.
- 2 Kahleova H, Matoulek M, Malinska H, Oliyarnik O, Kazdova L, Neskudla T *et al.* Vegetarian diet improves insulin resistance and oxidative stress markers more than conventional diet in subjects with Type 2 diabetes. *Diabet Med* 2011; **28**: 549–559.
- 3 Barnard ND, Cohen J, Jenkins DJ, Turner-McGrievy G, Gloede L, Jaster B *et al.* A low-fat vegan diet improves glycaemic control and cardiovascular risk factors in a randomized clinical trial in individuals with type 2 diabetes. *Diabetes Care* 2006; **29**: 1777–1783.
- 4 Nicholson AS, Sklar M, Barnard ND, Gore S, Sullivan R, Browning S. Toward improved management of NIDDM: a randomized, controlled, pilot intervention using a low-fat, vegetarian diet. *Prev Med* 1999; **29**: 87–91.
- 5 Wagenknecht M, Hainer V, Kunesová M, Bellisle F, Parížková J, Braunerová R *et al.* Vztahy mezi faktory “jídelního chování”, socioekonomickým stavem, antropometrickými indexy tělesného tuku a zdravotními riziky v české populaci (Relationships between the ‘eating inventory’ factors, socio-economic status, anthropometric body adiposity indexes and health risks in the Czech population). *Cas Lek Cesk* 2007; **146**: 284–291.
- 6 Ferrannini E. The theoretical bases of indirect calorimetry: a review. *Metab Clin Exp* 1988; **37**: 287–301.
- 7 Mann JI, De Leeuw I, Hermansen K, Karamanos B, Karlström B, Katsilambros N *et al.* Evidence-based nutritional approaches to the treatment and prevention of diabetes mellitus. *Nutr Metab Cardiovasc Dis* 2004; **14**: 373–394.
- 8 Patrick DL, Bushnell DM, Rothman M. Performance of two self-report measures for evaluating obesity and weight loss. *Obesity* 2004; **12**: 48–57.
- 9 Stunkard AJ, Messick S. The three-factor eating questionnaire to measure dietary restraint, disinhibition and hunger. *J Psychosom Res* 1985; **29**: 71–83.
- 10 Steer RA, Cavalieri TA, Leonard DM, Beck AT. Use of the Beck Depression Inventory for Primary Care to screen for major depression disorders. *Gen Hosp Psychiatry* 1999; **21**: 106–111.
- 11 Katcher HI, Ferdowsian HR, Hoover VJ, Cohen JL, Barnard ND. A worksite vegan nutrition program is well-accepted and improves health-related quality of life and work productivity. *Ann Nutr Metab* 2010; **56**: 245–252.
- 12 Beezhold BL, Johnston CS. Restriction of meat, fish, and poultry in omnivores improves mood: a pilot randomized controlled trial. *Nutr J* 2012; **11**: 9.
- 13 Beezhold BL, Johnston CS, Daigle DR. Vegetarian diets are associated with healthy mood states: a cross-sectional study in Seventh-day Adventist adults. *Nutr J* 2010; **9**: 26.
- 14 Maher TJ. Effects of nutrients on brain function. *Prog Brain Res* 2000; **122**: 187–194.
- 15 Barnard ND, Gloede L, Cohen J, Jenkins DJ, Turner-McGrievy G, Green AA *et al.* A low-fat vegan diet elicits greater macronutrient changes, but is comparable in adherence and acceptability, compared with a more conventional diabetes diet among individuals with type 2 diabetes. *J Am Diet Assoc* 2009; **109**: 263–272.