Effects of lifestyle advice in people newly diagnosed with type 2 diabetes

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Article points

1. The primary objective was to investigate the effectiveness of general lifestyle advice given to people newly diagnosed with type 2 diabetes in relation to body composition, metabolic profiles and insulin sensitivity.
2. Fourteen treatment-naïve people with type 2 diabetes diagnosed in the preceding 3 months with no clinical evidence of complications were recruited from a diabetes clinic.
3. Lifestyle advice alone failed to sustain the observed improvements and more intense health interventions may probably be needed to affect a change.

Key words

- Body composition
- Lifestyle
- Insulin resistance
- Insulin secretion

Authors' details can be found at the end of the article.

Lifestyle advice is routinely given to people with diabetes in primary care; however, the extent to which this advice improves body composition and glycaemic control is difficult to measure. The authors of this study investigated the impact of routine lifestyle advice on body composition and HbA_{1c} level in newly diagnosed treatment-naïve people with type 2 diabetes. Participants underwent a thorough assessment including anthropometric measurements, metabolic parameters and dual energy X-ray absorptiometry (DXA) scan, and given lifestyle advice at baseline and 8 weeks. Assessment took place again at 24 weeks. The authors of this article report their primary care research.

The global prevalence of diabetes and its vascular complications have reached epidemic proportions and look set to continue unabated, fuelled by the parallel increase in obesity and a lack of physical activity (Blair and Church, 2003; LaMonte et al, 2005). People presenting with newly diagnosed type 2 diabetes should initially undergo changes to both diet and levels of physical activity, as these have been identified as cornerstones of diabetes management (Sigal et al, 2004). Physical activity guidelines to improve and maintain health recommend a minimum of 30 accumulated minutes of moderate physical activity, 5 days per week (Pate et al, 1995). However, people with type 2 diabetes report receiving less encouragement, education and support for increasing physical activity compared with any other aspects of diabetes management (Wilson et al, 1986). Structured exercise programmes have been used in a number of studies to investigate the different effects of physical activity on diabetes management (Boulé et al, 2003). These exercise programmes are costly and mostly undertaken by people who are already interested in physical activity.

The primary objective of the current study was therefore to investigate the effectiveness of general lifestyle advice, similar to that given in many diabetes clinics, to people newly diagnosed with type 2 diabetes in relation to body composition, metabolic profiles and insulin sensitivity over a period of 8 weeks, and a further period of 16 weeks.

Participants and methods

Participants

Fourteen treatment-naïve people with type 2 diabetes diagnosed in the preceding 3 months were recruited from a diabetes clinic. Exclusion criteria comprised: clinical evidence of complications, indications of ischaemia or cardiac disease at rest, problems with mobility, current use of anti-inflammatory drugs, severe asthma, taking corticosteroids, thyroxine or growth hormones. None of the participants had previously participated in an exercise intervention study. The experimental protocol was approved by the South East Wales Research Ethics Committee. All participants received written and verbal information regarding the nature and potential risks of the study and they were required to provide signed informed consent prior to participating. Approval for participation was also received from each person's general practitioner.

Lifestyle advice

At the start of the study, participants received general lifestyle advice consisting of a consultation with a dietitian at which their current diet was assessed. They were then given advice on healthy eating and advised to decrease carbohydrate and fat content and energy intake by 500 to 1000 kcal/day depending on whether they were overweight or obese, respectively. A meal plan with the required deficit in calories was given to all participants to follow. In addition, consultation with a physiotherapist took place, aimed at increasing physical activity in a tailored, graded manner. The dietary and physiotherapy advice was reinforced at visit 2 at 8 weeks.

Maximal oxygen uptake and body composition

Participants performed a 6-minute single-stage submaximal exercise session on a cycle ergometer. Starting workload was determined using a standard protocol table (Astrand and Ryhming, 1954), designed to elicit a heart rate of between 125 and 175 beats/min by 6 minutes. The work output was adjusted as necessary during the test to achieve a heart rate in this range for the individual. The heart rate response to this session was used to predict the maximal aerobic capacity (VO_{2max}). The Astrand-Ryhming nomogram was used by plotting the average heart rate for the fifth and sixth minute on the appropriate gender scale on the nomogram, along with the corresponding work rate in kpm/min. A correction factor table to correct the VO_{2max} for age was then used to estimate the individual's VO_{2max}. The test was performed at the initial visit and at study end (visit 3 at 24 weeks).

Height (m) was measured with a stadiometer, weight (kg) with electronic scales and waist circumference (cm) with a tape measure. A whole body dual-energy X-ray absorptiometry (DXA) scan was performed to determine total fat mass (kg) and truncal fat mass (kg and as % of total) at all three visits using a Hologic QDR Discovery – a dual energy X-ray absorptiometer with software version 12.1.

Meal tolerance test

The meal tolerance test (MTT) was conducted at baseline and weeks 8 and 24. The test was commenced at 08.00 after an overnight fast of 10 hours. A cannula was inserted into an antecubital fossa vein with a slow running saline infusion to maintain patency of the vein. Fasting samples were taken for glucose, insulin and C-peptide. Following the 0-minute sample participants consumed a standard 500 kcal mixed meal (58% carbohydrate, 22% protein, 20% fat) and blood samples taken at regular intervals, as previously described (Peter et al, 2006). Samples taken during the MTT were assayed for glucose and insulin.

Laboratory and data analysis

Plasma glucose was measured by a hexokinase assay (Diasys, Germany) using an automated analyser (Sapphire 180, Biostat, UK) and insulin measured by highly specific and sensitive immuno-chemiluminometric assay (Invitron, Monmouth, UK). HbA_{1c} levels were measured using an automated analyser

Page points

1. Fourteen treatment-naïve people with type 2 diabetes diagnosed in the preceding 3 months with no clinical evidence of complications were recruited from a diabetes clinic.
2. At the start of the study, participants received general lifestyle advice consisting of a consultation with a dietitian at which their current diet was assessed.
3. Participants performed a 6-minute single-stage submaximal exercise session on a cycle ergometer.
4. The meal tolerance test was conducted at baseline and weeks 8 and 24. The test was commenced at 08.00 after an overnight fast of 10 hours.

Page points

1. Insulin sensitivity was calculated by homeostasis model assessment (HOMA Calculator V2.2.2) using fasting insulin and glucose concentrations.
2. The study was not intended to show a statistically significant difference between the three visits and was therefore not powered to do so.
3. Comparison across the three visits was conducted using the Friedman test. Differences between visits were explored using the Wilcoxon's signed rank test.

(TOSOH HLC-732 G7, TOSOH Bioscience, Belgium) (Terreni et al, 2003). All analyses were performed in the diabetes research unit laboratory or routine haematology laboratory, University Hospital Llandough, Wales, UK.

Insulin sensitivity

Insulin sensitivity was calculated by homeostasis model assessment (HOMA Calculator V2.2.2) using fasting insulin and glucose concentrations (Levy et al, 1998).

Statistical analysis

The study design provided 14 people on active treatment from whom clinical data were collected. This was considered optimal to achieve sufficient data to inform future study designs and on which to base future sample size calculations. The study was not intended to show a statistically significant difference between the three visits and was therefore not powered to do so. Normality was determined using the Shapiro-Wilk goodness-of-fit test for continuous data; data did not meet the assumptions for parametric statistics and are hence expressed as median [range]. Comparison across the three visits was conducted using the Friedman test. Differences between visits were explored using the Wilcoxon's signed rank test. Statistical significance was set at $P<0.05$ and adjusted accordingly for post-hoc comparisons. Statistical analysis was performed using SPSS (SPSS Incorporated, Chicago, Windows version 17.0).

Results

Fourteen people (male, 13; age, 58.7±8.5 years) completed the 24-week study. Descriptive characteristics for the individuals at visits one, two and three are shown in *Table 1*. Comparison across the three visits revealed a decrease in anthropometric measurements (body mass, BMI, waist

Table 1. Descriptive characteristics at visits one to three.

Variable	Visit 1 Baseline	Visit 2 8 weeks	Visit 3 24 weeks	Across visits *P*-value
Body mass (kg)	90.3 [67.7–120.9]	90.3 [66.8–119.2]**	86.5 [67.4–122.1]**	0.011
Height (m)	1.71 [1.64–1.84]	-	-	-
BMI (kg/m^2)	30.4 [23.2–39.7]	29.5 [22.8–39.4]**	29.0 [23.3–39.1]**	0.013
Waist circumference (cm)	105 [86–136]	103 [85–132]*	98 [87–137]**	0.025
Total fat mass (kg)	48.7 [33.5–66.8]	47.0 [34.2–64.1]	44.8 [35.8–66.5]	NS
Truncal fat mass (kg)	16.0 [8.9–28.2]	14.9 [8.6–26.2]	13.7 [8.1–28.4]	NS
Truncal fat % of total	32.8 [23.3–42.3]	31.6 [21.8–41.9]	31.2 [20.9–42.6]	NS
Fasting glucose (mmol/L)	7.6 [5.3–10.0]	7.2 [6.2–9.3]	7.4 [5.9–10.3]	NS
HbA_{1c} (%)	6.4 [5.3–8.4]	5.9 [5.2–6.6]**	6.3 [5.5–7.4]††	0.004
Fasting insulin (pmol/L)	97 [16–166]	73 [19–229]	69 [20–254]	NS
Total cholesterol (mmol/L)	5.1 [4.1–7.5]	4.8 [2.9–6.5]	5.1 [3.6–6.7]	NS
HDL cholesterol (mmol/L)	1.2 [0.7–1.4]	1.1 [0.7–1.5]	1.1 [0.7–1.4]	NS
LDL cholesterol (mmol/L)	3.1 [1.6–5.2]	3.1 [1.2–4.2]	3.2 [1.7–5.0]	NS
Triglycerides (mmol/L)	1.7 [0.7–4.2]	1.3 [0.5–4.5]	1.5 [0.5–3.3]	NS
Systolic blood pressure (mmHg)	140 [121–184]	134 [121–157]	132 [114–158]	NS
Diastolic blood pressure (mmHg)	88 [78–100]	81 [74–97]	83 [64–92]	NS
VO_2max (L/min)	2.1 [1.2–3.3]	-	2.2 [1.6–2.7]	NS

*$P<0.05$ versus visit 1; **$P<0.01$ versus visit 1; †$P<0.05$ versus visit 2; ††$P<0.01$ versus visit 2
HDL=high density lipoprotein; LDL=low density lipoprotein.

circumference) from visit one to two, which were maintained at visit three (*Figure 1*). These significant decreases in anthropometric measurements were not reflected in the DXA body composition data, although trends could be detected in the same direction. HbA_{1c} levels decreased significantly from 0 to 8 weeks, but then increased, almost returning to baseline values by 24 weeks.

There were no significant differences in total cholesterol, LDL- and HDL-cholesterol fractions or triglyceride concentrations between the three visits. Although there were no significant differences in systolic and diastolic blood pressure readings between the three visits, again there was a trend towards reduction between visits one and two, which plateaued at visit three (*Figure 1*).

VO_{2max} results have been provided in *Table 1* and the test explained in the methods section. The differences were not significant, as indicated, but this may be a reflection of the test method and the small numbers involved in the study. Perhaps using more intensive methods to determine peak oxygen uptake (VO_{2peak}), as described by the authors in a previous article (Peter et al, 2005), may have provided different results.

Metabolic and hormonal profiles during MTT

Patients' responses to a standard MTT at visits one to three are shown in *Figure 2*. Comparison for fasting glucose (*Table 1*), demonstrated no significant changes following visit one and two.

There were also no significant differences in fasting insulin concentrations. There was a trend towards reduction between visits one and two, which then reached a plateau at visit three (*Figure 2*).

Insulin sensitivity

$HOMA_{IR}$ again demonstrated no significant changes but reduced from visits one to three (2.2 vs 1.9 vs 1.5, respectively).

Discussion

The primary objective of the current study was to investigate the effectiveness of usual lifestyle advice, a format undertaken in routine diabetes clinics, in the form of a nutrition and physical activity consultation, on body composition, metabolic profiles and insulin sensitivity in people newly diagnosed with type 2 diabetes.

In the first 8 weeks, HbA_{1c} levels decreased significantly by 0.5% (6.4% [46 mmol/mol] versus 5.9% [41 mmol/mol]; $P<0.01$) but then increased by 0.4% (4.4 mmol/mol) from 8 to 24 weeks. The clinical significance of this finding can be gauged from the UK Prospective Diabetes Study (UKPDS Group; 1998) where HbA_{1c} level decreased by 0.6% (6.6 mmol/mol) among participants randomised to intensive glycaemic control with metformin. This reduction was associated with significant reductions in several diabetes-related end-points, although it must be

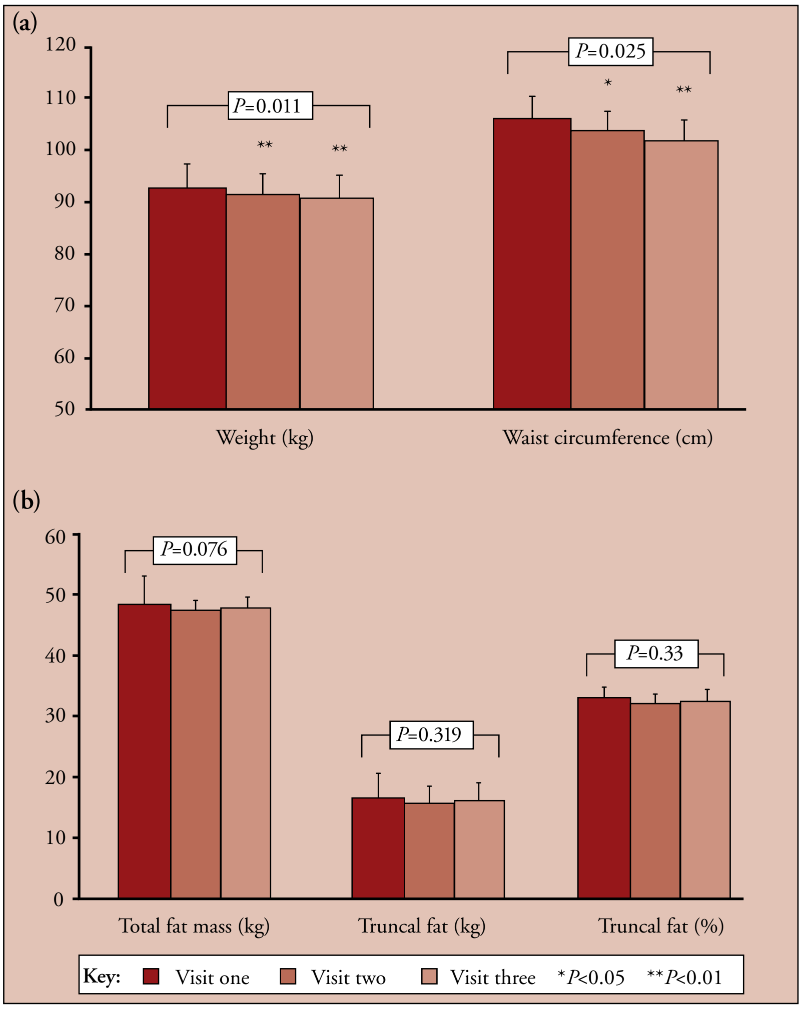


Figure 1. Body weight and waist circumference (a) and whole body composition measured using dual-energy X-ray absorptiometry scan (b) at baseline (visit one), 8 weeks (visit two) and 24 weeks (visit three) following lifestyle advice.

pointed out that baseline HbA_{1c} level was higher in the UKPDS (8.0% [64 mmol/mol] vs 7.4% [57 mmol/mol]). BMI decreased from 0 to 8 weeks (30.4 vs 29.5 kg/m^2), and between 0 and 24 weeks (30.4 vs 29.0 kg/m^2) – both P<0.01. Similarly, the mean total fat mass and truncal fat mass measured by DXA decreased with time, although the changes did not reach statistical significance.

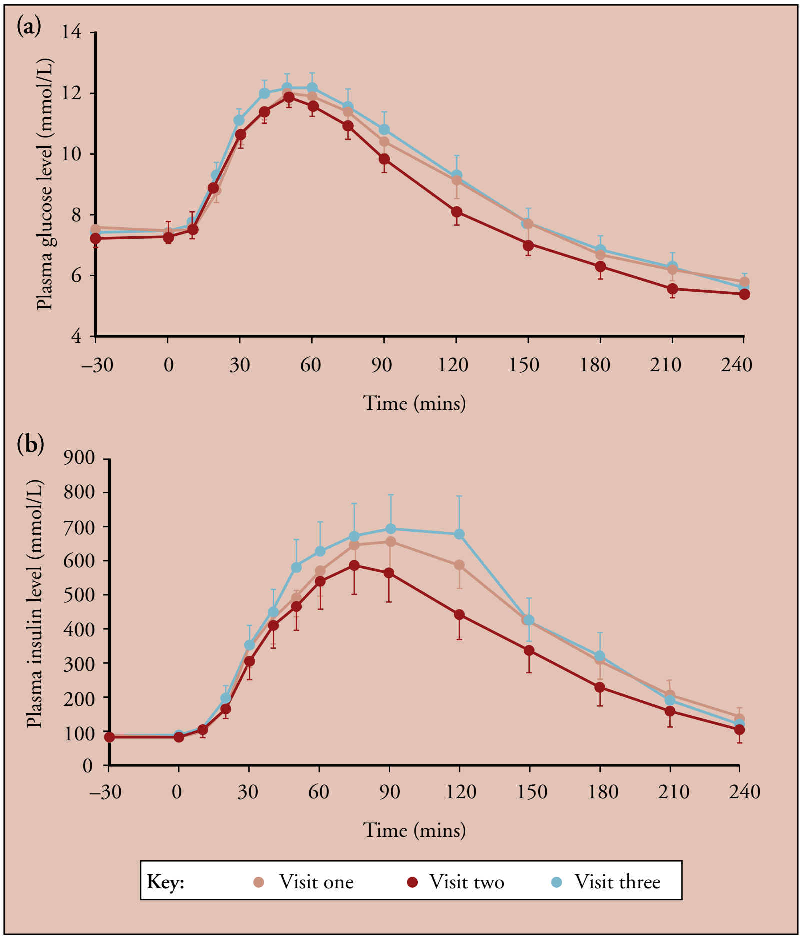
A meta-analysis of exercise interventions by Boulé et al (2001) concluded that improved HbA_{1c} concentrations were mediated by exercise and not by changes in body mass. Therefore, exercise should be viewed as beneficial in its own right and not merely as an avenue to weight loss. The meta-analysis found that exercise interventions alone reduced HbA_{1c} by ~0.7% (~7.7 mmol/mol) (8.3% [67 mmol/mol] nonexercise group versus 7.7% [61 mmol/mol] control group; P<0.001). Reductions in HbA_{1c} level of 1.8% (19.7 mmol/mol) and body mass of 1.0 kg have also been found by Goldhaber-Fiebert et al (2003) following a 12-week, tri-weekly, 60-minute walking group session.

Dunstan et al (2002) also achieved a significantly greater reduction in HbA_{1c} in a resistance training plus weight loss group when compared with the weight-loss only group at 3 months (0.6% [6.6 mmol/mol] vs 0.07% [0.8 mmol/mol]), again demonstrating that exercise has a positive impact on HbA_{1c} levels.

One of the first defects seen in the development of type 2 diabetes is a decrease or loss in the first phase insulin response (Owens et al, 1996). In the present study, a significant improvement in HbA_{1c} levels was observed during the first 8 weeks, which may suggest an initial recovery of the beta-cell function and insulin sensitivity, although the differences failed to reach statistical significance. This may well indicate that in newly diagnosed people even modest changes in anthropometric profiles will be of benefit.

In people with type 2 diabetes, high levels of visceral adiposity leads to elevated plasma non-esterified fatty-acid levels, increased fatty-acid oxidation and decreased basal glucose utilisation and oxidation (Weyer et al, 1999). Evidence

Figure 2. Plasma glucose (a) and insulin (b) responses to a standard meal tolerance test at baseline (visit one), 8 weeks (visit two) and 24 weeks (visit three) following lifestyle advice.



also supports the association of dyslipidaemia and insulin resistance with increased visceral adiposity (Després et al, 1990; O'Leary et al, 2006). Waist circumference, indicative of visceral adipose tissue, decreased significantly by 2 cm (105 vs 103 cm; $P<0.05$) in the first 8 weeks and continued to decrease by another 5 cm in the following 4 months reaching 98 cm ($P=0.025$; 0 to 24 weeks). Trends in decreasing truncal, total fat mass and percentage truncal fat were also observed for the same time intervals. These changes were not, however, reflected in statistically significant improvements in lipid profiles, although a non-significant decrease in total cholesterol, LDL, and triglyceride levels was observed during the first 8 weeks.

Schenk and Horowitz (2007) observed that acute exercise increases triglyceride synthesis in skeletal muscle and therefore prevents fatty-acid-induced insulin resistance. Exercise may also result in increased fat oxidation leading to a reduction in lipotoxicity in skeletal muscle, liver and/or the pancreas (Slentz et al, 2009), and in conjunction with decreased waist circumference indicative of reduced visceral adipose tissue, may help explain the trends in lipid profile observed in the first 8 weeks of this study.

The present study does provide evidence to suggest that conventional nutrition and physical activity advice given at diagnosis of type 2 diabetes achieved an initial improvement in anthropometric measurements and glycaemic control, but was short-lived. Thereafter, lifestyle advice alone failed to sustain these observed improvements and more intense health interventions may probably be needed to affect a change. This was explored by the Look AHEAD (Action for Health in Diabetes; Look AHEAD Research Group et al, 2007) trial where participants were seen weekly with three group meetings and a monthly individual meeting by intervention teams that included dietitians, exercise specialists and behavioural psychologists for the first 6 months, achieving an average weight loss of 8.6% and significant changes in metabolic profile.

Conclusion

For lifestyle changes to be effective, more contact with relevant healthcare professionals dealing with nutrition and physical fitness is likely to be needed as participants seemed to lose the impetus to continue with the lifestyle changes initially undertaken. Hence, although lifestyle advice should be introduced as an integral part of long-term diabetes management, it may need to be more intensive and reinforced constantly if it is to succeed. ■

Declaration of competing interests

Nothing to declare. There was no external funding or support for the study.

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Astrand PO, Ryhming I (1954) *J Appl Physiol* **7**: 218–21

Blair SN, Church TS (2003) *Diabetes Spectrum* **16**: 236–40

Boulé NG, Haddad E, Kenny GP et al (2001) *JAMA* **286**: 1218–27

Boulé NG, Kenny GP, Haddad E et al (2003) *Diabetologia* **46**: 1071–81

Després JP, Moorjani S, Lupien PJ (1990) *Arteriosclerosis* **10**: 497–511

Dunstan DW, Daly RM, Owen N et al (2002) *Diabetes Care* **25**: 1729–36

Goldhaber-Fiebert JD, Goldhaber-Fiebert SN, Tristán ML, Nathan DM (2003) *Diabetes Care* **26**: 24–9

LaMonte MJ, Blair SN, Church TS (2005) *J Appl Physiol* **99**: 1205–13

Levy JC, Matthews DR, Hermans MP (1998) *Diabetes Care* **21**: 2191–2

Look AHEAD Research Group, Pi-Sunyer X, Blackburn G et al (2007) *Diabetes Care* **30**: 1374–83

O'Leary VB, Marchetti CM, Krishnan RK et al (2006) *J Appl Physiol* **100**: 1584–9

Owens DR, Luzio SD, Coates PA (1996) *Diabet Med* **13**(Suppl 6): S19-24

Pate RR, Pratt M, Blair SN et al (1995) *JAMA* **273**: 402–7

Peter R, Luzio SD, Dunseath G et al (2005) *Diabetes Care* **28**: 560–5

Peter R, Luzio SD, Dunseath G et al (2006) *Diabet Med* **23**: 990–5

Schenk S, Horowitz JF (2007) *J Clin Invest* **117**: 1690–8

Sigal RJ, Kenny GP, Wasserman DH, Castaneda-Sceppa C (2004) *Diabetes Care* **27**: 2518–39

Slentz CA, Tanner CJ, Bateman LA et al (2009) *Diabetes Care* **32**: 1807–11

Terreni A, Paleari R, Caldini A et al (2003) *Clin Biochem* **36**: 607–10

UK Prospective Diabetes Study (UKPDS) Group (1998) *Lancet* **352**: 854–65

Weyer C, Bogardus C, Mott DM, Pratley RE (1999) *J Clin Invest* **104**: 787–94

Wilson W, Ary DV, Biglan A et al (1986) *Diabetes Care* **9**: 614–22

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