Proceedings of the Nutrition Society

Abstracts of Original Communications

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Objectively measured habitual physical activity and inactivity in a representative sample of 3–4-year-old children. By D.M. JACKSON[1,2], J.J. REILLY[1], L.A. KELLY[1], C. MONTGOMERY[1], S. GRANT[3] and J.Y. PATON[4], [1]*University of Glasgow Department of Human Nutrition, Yorkhill Hospitals, Glasgow G3 8SJ,* [2]*Rowett Research Institute, Division of Appetite and Energy Balance, Greenburn Rd, Bucksburn, Aberdeen AB21 9SB,* [3]*University of Glasgow Centre for Exercise Science and Medicine, Gilmorehill, Glasgow G12 8QQ and* [4]*University of Glasgow Department of Child Health, Yorkhill Hospitals, Glasgow G3 8SJ*

The recent epidemic of obesity in children (Reilly *et al.* 1999) has increased awareness of physical inactivity as a public health problem. The absence of increased energy intake over the same period among children implies that habitual physical activity has declined in recent years. Improved understanding of childhood physical activity/inactivity levels and patterns would facilitate the design of obesity prevention strategies. However, there is a paucity of data on objectively measured physical activity in representative samples of children. This study aimed to (a) describe levels of physical activity and inactivity in a representative sample of pre-school children, (b) assess influences on total activity, and (c) quantify tracking of activity and inactivity over 1 year.

Physical activity (mean accelerometry count/min) and inactivity (percentage of time below 1100 counts/min; Reilly *et al.* 2001) was assessed over three days (two weekdays, one weekend day) using the Computer Science and Applications WAM-7164 (CSA) accelerometer in a representative sample of 3–4-year-old children (104 children; 52 boys; mean age 3.7 years, SD 0.4) in 1999. In sixty children (thirty boys) measurements were repeated 1 year later. We also measured a range of possible demographic and environmental correlates of physical activity and determined their relationship to total activity using univariable and multiple regression analyses.

Gender, age, and ambient temperature all significantly influenced total activity, and in a multiple regression model explained 21% of variation in total activity. Activity level significantly increased from baseline to follow up (paired *t*-test $P<0.001$). Activity level increased from 669 counts/min (SD 165) in 1999 to 849 (252) in 2000. The activity tracking coefficient from baseline (1999) to follow up (2000) was $r=0.40$ ($P<0.01$) for rank order correlations. Engagement in sedentary behaviour was high, 76% of total time (SD 7) on average in boys and 80% of total time (SD 6) in girls at baseline.

We conclude that contemporary pre-school children are extremely inactive and engagement in sedentary behaviour was as high as reported in a recent study of adolescents from the USA (Strauss *et al.* 2001). Some of the variation in activity (as measured by accelerometry output) could be explained by identifiable and measurable correlates. However, the precise biological significance of differences in accelerometry-defined activity remains unclear. This must be the focus of future research given the undoubted potential of the technology.

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Strauss RS, Rodzilsky D, Burack G & Colin M (2001) *Archives of Pediatrics and Adolescent Medicine* **155**, 897–902.

Systematic review of exercise and the long-term outcomes of the treatment for obesity. By T.J. BROWN[1], A. AVENELL[1], J. BROOM[2], W.C.S. SMITH[3], R. JUNG[4], M.K. CAMPBELL[1] and A.M. GRANT[1], [1]*Health Services Research Unit, University of Aberdeen, Foresterhill, Aberdeen AB25 2ZD,* [2]*Grampian University Hospitals NHS Trust, Aberdeen Royal Infirmary, Foresterhill, Aberdeen AB25 2Z,* [3]*Department of Public Health, University of Aberdeen, Foresterhill, Aberdeen AB25 2ZD and* [4]*Tayside University Hospitals NHS Trust, Ninewells Hospital, Dundee DD1 9SY*

We systematically reviewed randomised controlled trials (RCTs) of obesity treatments in adults and assessed long-term effects on weight and risk factors for disease.

RCTs of exercise were included only where exercise was provided in conjunction with dietary advice. RCTs had to have a mean follow-up of at least 1 year and had to recruit adults with a mean baseline BMI of at least 28 kg/m^2. An exercise intervention was classified as such if a detailed programme of exercise was reported. If participants were advised to simply take more exercise this was not classed as an exercise intervention. The main outcomes assessed were weight, lipids, blood pressure and glycaemic control.

Thirteen electronic databases were searched and key journals were hand-searched. Three studies examined the effects of diet and exercise versus control, twelve studies examined the effects of diet and behaviour therapy and exercise versus control, five studies assessed the added effects of exercise to diet, two studies assessed the added effect of behaviour therapy and exercise to diet and seven studies assessed the added effect of exercise to diet and behaviour therapy.

The added effect of exercise to diet was associated with a weighted mean difference (WMD) weight change of −1.95 kg (95% CI, −3.22 kg to −0.68 kg) at 12 months, −7.63 kg (95% CI, −10.33 kg to −4.92 kg) at 18 months and −8.22 kg (95% CI, −15.27 kg to −1.16 kg) at 36 months. Two studies demonstrated beneficial effects of adding exercise to diet at 12 months for HDL cholesterol (WMD 0.1 mmol/l; 95% CI, 0.06 to 0.14 mmol/l) and for triacylglycerols (WMD −0.18 mmol/l; 95% CI, −0.31 to −0.06 mmol/l).

The added effect of exercise to diet and behavioural therapy was associated with a WMD weight change of −3.02 kg (95% CI, −4.94 kg to −1.11 kg) at 12 months and −2.16 kg (95% CI, −4.20 kg to −0.12 kg) at 24 months. Few studies presented changes in risk factors, with only one statistically significant result for the added effect of exercise being associated with a deleterious increase in LDL cholesterol at 24 months (WMD 0.28 mmol/l; 95% CI, 0 to 0.56 mmol/l), based on one small study only.

At 1 year, the addition of exercise to diet was associated with improved weight loss and risk factors. The data suggests that a prescribed exercise programme is particularly important in long-term weight maintenance. The amount and type of exercise received by participants varied across studies. Also in some studies the exercise component accounted for extra contact visits, therefore it might have been the extra contact time rather than the actual exercise intervention that produced increased weight loss.

Methodological limitations included inadequate sample size and reporting. Only two small studies examined exercise as an adjunct to diet post-12 months. Few studies reported risk factor outcomes and there was very little evidence regarding the additional effect of exercise on clinical outcomes.

Seasonal variation in energy metabolism and body composition in Dutch men and women. By G. PLASQUI and K.R. WESTERTERP, *Department of Human Biology, Maastricht University, PO Box 616, 6200 MD Maastricht, The Netherlands*

In many undeveloped countries around the world, food availability and workload varies with season. As a consequence, there are changes in body weight during the year (Panter-Brick, 1995). In industrialized countries, varied food availability is guaranteed throughout the whole year and, for most people, workload is independent of the season. Still, in these countries body weight also shows an annual cycle, with an increase in winter and a decrease in summer (Van Staveren *et al*. 1986). Several factors, such as energy intake, physical activity and resting metabolic rate (RMR), have been suggested as possible contributors to seasonal changes in energy metabolism. Changes in energy intake are difficult to detect, since the measurement error of energy intake exceeds the changes to be expected from seasonal influences. Physical activity seems to peak during spring and summer, but the methods investigating this aspect were often limited to questionnaires. RMR could change over seasons, with a peak in winter possibly triggered by cold and a consequent increase in thyroid activity. Most studies, however, only investigated changes in thyroid hormones and not RMR. Furthermore, few studies included data on body composition. Therefore, we were interested in seasonal changes in body weight, body composition and energy expenditure, with special attention to physical activity and physical fitness.

Twenty-five healthy volunteers (10 males and 15 females, BMI 20.9±2.0 and 21.9±1.9 respectively) between the ages of 20 and 30 years were examined four times during the year: in summer (July, August), autumn (October, November), winter (January, February) and spring (April, May). Body weight (BW) was measured to the nearest 0.01 kg. Body composition was determined using a three-compartment model based on underwater weighing and the ^{2}H dilution method. Sleeping metabolic rate (SMR) was measured during an overnight stay in a respiration chamber. Total energy expenditure (TEE) was determined with doubly labelled water during summer and winter. As a measure of physical fitness W_{max} was determined on a cycle-ergometer.

Data from summer, autumn and winter have already been collected. For the total group, BW did not significantly change between seasons, being 66.68 kg in summer, 66.72 kg in autumn and 67.12 kg in winter. Analysing the data for males and females separately revealed a significantly higher BW for males in winter (71.06 kg) than in both summer (69.98 kg, P=0.006) and autumn (70.08 kg, P=0.011), whereas this was not found in females (64.70 kg in summer, 64.71 kg in autumn and 64.76 kg in winter, P=0.98). In males, fat mass (FM) was significantly higher in winter (11.40 kg) than in both summer (10.21 kg, P=0.0097) and autumn (10.51 kg, P=0.044). In females, no significant changes in FM were observed. For both groups, fat-free mass (FFM) remained unchanged over seasons. Despite a constant FFM, sleeping metabolic rate did change. For men and women, SMR was lowest in summer (4.33 kJ/min), rising to 4.50 kJ/min in autumn (P=0.0005) and 4.52 kJ/min in winter (P=0.0001). TEE did not significantly change between seasons but the physical activity level (PAL) was significantly lower during winter (1.86 *v*. 1.76, P=0.005). The change in PAL was not reflected in a change in W_{max}.

In conclusion, in winter SMR is higher but PAL is lower, resulting in no change in TEE. Men have a higher FM in winter, probably due to an increase in energy intake. From these data it seems that women are more resistant to seasonal influences than men, perhaps due to a more restrained eating behaviour.

Panter-Brick C (1995) *Journal of Biosocial Science* **27**, 215–233.
Van Staveren WA, Deurenberg, P, Burema J, De Groot LC & Hautvast JG (1986) *International Journal of Obesity* **10**, 133–145.

Physical activity costs in obese and non-obese adolescents. By S. LAZZER[1], M. VERMOREL[2], A. BITAR[3], M. MEYER[4] and Y. BOIRIE[1], [1]*Protein Energy Metabolism Unit, INRA, University of Auvergne, 63001 Clermont-Ferrand, France,* [2]*Energy and Lipid Metabolism Research Unit, INRA, Theix, 63122 St Genès Champanelle, France,* [3]*Department of Biology, Applied Physiology Laboratory, Faculty of Sciences, El Jadida, Morocco and* [4]*Hôtel-Dieu Pediatric Hospital, 63001 Clermont-Ferrand, France*

Childhood obesity is rapidly emerging as a global epidemic that will have profound public health consequences in Western societies. Epidemiological trends in obesity suggest that the primary causes of overweight are environmental and behavioural changes. The objectives of the present study were to determine (1) daily energy expenditure (EE) and its main components, (2) time devoted to, EE, and energy cost of various sedentary and physical activities in obese (O) and non-obese (NO) adolescents in whole-body calorimeters and free-living conditions.

Twenty-seven (thirteen boys, fourteen girls) severely obese (O) and fifty-five (twenty-seven boys, twenty-eight girls) non-obese (NO) adolescents aged 12 to 16 years participated in this study. Body composition was assessed by dual X-ray absorptiometry (DEXA) and bioimpedancemetry.

Basal metabolic rate (BMR) was measured by indirect calorimetry and was not significantly different between O and NO adolescents after adjustment for FFM. Subjects spent 36 h in whole-body calorimeters and followed a standardised activity programme including six periods of 20 min of walking on a treadmill. EE values during sleep and sedentary activities were non-significantly different between O and NO adolescents after adjustment for fat-free mass (FFM). EE during walking at the same speeds was significantly higher in O than in NO subjects, both in absolute terms (+81%) and after adjustment for body weight (BW, +25 %). Daily EE was higher in O than in NO subjects (13.9 *v.* 10.5 MJ/d, P<0.0001), even after adjustment for FFM (12.4 *v* 11.2 MJ/d, P<0.0001).

In free-living conditions EE was assessed during seven consecutive days by triaxial accelerometry, an activity diary and the heart rate (HR) recording method, using individual HR-EE relationships established by whole-body calorimetry over 24 h. EE during sleep and seated activities was non-significantly different between O and NO adolescents after adjustment for FFM. EE associated with physical activities (PAEE) was not significantly different between O and NO subjects (2.6 *v.* 2.9 MJ/d). The increase in physical activity EE (IPAEE) above resting EE (see Figure) was not significantly different between O and NO adolescents. Finally, DEE was higher in O than in NO subjects (12.6 *v.* 10.5 MJ/d, P<0.0001), but was not significantly different after adjustment for FFM. However, the O adolescents spent more time on light physical activities (shopping or slow walking) than the NO adolescents (128 *v.* 83 min/d, P<0.0001), but much less time on moderate (walking, leisure activities) physical activities (7 *v.* 57 min/d, P<0.0001) and leisure sport (13 *v.* 45 min/d, P<0.0001). EE during moderate physical activities and leisure sport contributed to PAEE by 18% in O subjects compared to 68% in NO subjects (P<0.0001).

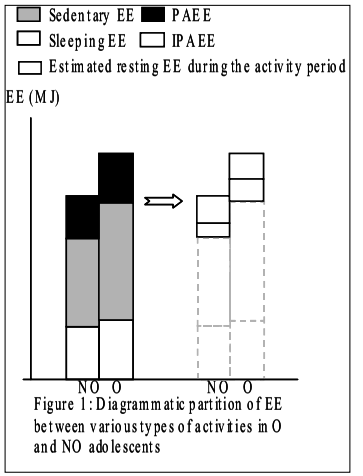


Figure 1: Diagrammatic partition of EE between various types of activities in O and NO adolescents

In conclusion, in free-living conditions, EE associated with all physical activities was not significantly different between O and NO subjects, but time and EE devoted to moderate physical activities and leisure sport were much lower in O adolescents.

Energy expenditure is better measured directly than by recall or diaries. By G.W. HORGAN[1], Z. FULLER[2], L. O'REILLY[2] and J. STUBBS[2], [1]*Biomathematics and Statistics Scotland, Rowett Research Institute, Aberdeen AB21 9SB and* [2]*Rowett Research Institute, Aberdeen AB21 9SB*

Energy expenditure in humans is most reliably measured by whole-body calorimetry or by the doubly-labelled water (DLW) technique. The former is impossible in free-living studies, while the latter is expensive. As part of a study to compare different methods of estimating typical energy intake (EI) and expenditure (EE) in humans (fifty-nine subjects consuming a normal diet with no prescribed exercise), we recorded EE by several methods, including DLW. The other methods used were Caltrac accelerometer (Muscle Dynamics Fitness Network, Torrance, USA), heart rate monitor (HRM) individually calibrated to oxygen consumption, a physical activity diary (PAD) and a 7 d physical activity recall (PAR7). Resting metabolic rate (RMR) was also measured. EI was measured directly by a complete food/leftover inventory, and also by subjects' weighed food diaries (EFD).

Correlations between the different measures of EE are shown below. Correlations are reasonably high, but much of this reflects between-subject differences already captured by RMR, which has as high a correlation with DLW as any other measure.

DLW	1.00							
EI	0.58	1.00						
EFD	0.65	0.87	1.00					
Caltrac	0.59	0.35	0.34	1.00				
PAD	0.58	0.59	0.52	0.48	1.00			
HRM	0.64	0.41	0.42	0.68	0.54	1.00		
PAR7	0.61	0.53	0.49	0.53	0.73	0.51	1.00	
RMR	0.65	0.69	0.61	0.51	0.83	0.63	0.79	1.00
	DLW	EI	EFD	Caltrac	PAD	HRM	PAR7	RMR

If physical activity levels (PAL=EE/RMR; mean=1.69; SD 0.26) are examined instead, the correlations appear much weaker.

DLW_PAL	1.00						
EI_PAL	0.22	1.00					
EFD_PAL	0.46	0.75	1.00				
Calt_PAL	0.43	0.09	0.15	1.00			
PAD_PAL	0.09	0.17	0.12	0.23	1.00		
HRM_PAL	0.36	0.01	0.14	0.45	0.00	1.00	
PAR7_PAL	0.28	–0.02	0.07	0.20	0.11	0.03	1.00
	DLW_PAL	EI_PAL	EFD_PAL	Calt_PAL	PAD_PAL	HRM_PAL	PAR7_PAL

None of the correlations between DLW and the other measures of EE can be considered good, as all are less than 0.5. This means that less than 25% of the variation in PAL between individuals is captured by any of these measures. If we used Calt_PAL (highest correlation) to predict PAL derived from DLW, the prediction error standard deviation will be 0.24. It is also apparent from the table that the measures based on activity diaries and recalls are even poorer. The evidence from these data suggests that subjects who are mostly sedentary lack the ability or willingness to properly assess their activity levels, and any information obtained in this way is of little value.

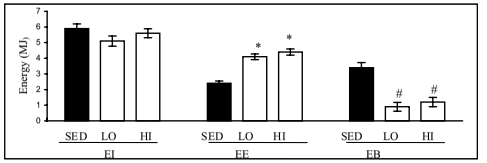
Lack of short-term energy compensation for imposed exercise in 9–10-year-old girls. By M.S. MOORE, C.J. DODD, J.R. WELSMAN and N. ARMSTRONG, *Children's Health and Exercise Research Centre, University of Exeter, Exeter EX1 2LU*

A poor physiological coupling between energy expenditure (EE) and energy intake (EI) may have a role in the attainment of a positive energy balance (EB), weight gain and the development of obesity. Studies in adults have shown little evidence of a compensatory increase in EI to account for an increase in EE (Blundell & King, 1999). This study was designed to investigate EI at different levels of EE in 9–10-year-old girls.

Nineteen girls, mean (SD) age 9.9 (0.5) years; BMI 18.5 (3.2) were recruited from a local school. A peak VO_2 test was conducted to obtain heart rate (HR) intensities corresponding to 50% and 75% peak VO_2. Children attended the Centre on three further occasions (08.30–17.30 hours) separated by at least 1 week. On one occasion children undertook only sedentary pursuits (SED), whilst the other visits consisted of a morning and afternoon exercise period of either high intensity (HI) (HR at 75% peak VO_2) or low intensity (LO) (HR at 50% peak VO_2) cycling in the laboratory. Each exercise bout was undertaken for the necessary duration, individually calculated for each child, to elicit similar EE (0.75 MJ), with children acting as their own controls. HI and LO exercise sessions commenced at 10.30 hours and 14.00 hours, in bouts of 15 min with rest periods (mean exercise duration LO 55 (7) min, HI 37 (5) min). EE was estimated from minute-by-minute HR monitoring throughout the day using the FLEX HR method (Ceesay *et al.* 1989).

Children consumed an identical breakfast within the Centre at 08.30 hours and ate an *ad libitum* lunch (12.30 hours) and dinner (17.00 hours), which was provided in excess at fixed times. These were of homogeneous macronutrient composition 35:53:12% (fat : carbohydrate : protein, as percentage energy) and meals were identical in each condition. Food was covertly weighed before and after meals.

EI, EE and EB were compared in each condition using repeated measures ANOVAs with follow-up paired-samples *t*-tests.



Mean (SE) EI (lunch+dinner), EE (09.30–17.00 hours) and EB (EI minus EE) in each condition.
*Significantly different from SED EE $P < 0.001$; #significantly different from SED EB $P < 0.001$.

In accordance with the study design, EE (09.30–17.00 hours) was significantly higher ($P<0.001$) in LO and HI (mean (SD) 4.1 (0.77) and 4.4 (0.88) MJ, respectively) compared with SED (2.4 (0.62) MJ). However EI (lunch+dinner) was similar in all three conditions, showing no evidence of exercise-induced energy compensation. Therefore relative EB (EI minus EE) was significantly more positive in SED (3.4 (1.4) MJ) than in either LO or HI (0.9 (1.2) and 1.2 (1.3) MJ, respectively).

These findings are in line with results from similar studies in adults (Blundell & King, 1999), implying that imposed exercise in children may influence body weight regulation. Longer-term studies are required in this age group in order to identify any later compensatory effects.

Blundell JE & King NA (1999) *Medicine and Science in Sports and Exercise* **31**, S497–S667.
Ceesay SM, Prentice AM, Day KC, Murgatroyd PR, Goldberg GR, Scott W & Spurr GB (1989) *British Journal of Nutrition* **61**, 175–186.

Does a community-based practical food skills intervention (CookWell) assist dietary change? By K. VALENTINE[1], P.J. LONGBOTTOM[1], W.L. WRIEDEN[1], A.S. ANDERSON[1] and E. DOWLER[2], *Centre for Public Health Nutrition Research, University of Dundee, Ninewells Hospital and Medical School, Dundee DD1 9SY and [2]Department of Sociology, University of Warwick, Coventry CV4 7AL*

There is a well-recognized need to increase intakes of fruit and vegetables, fibre-rich starchy carbohydrates and fish, but many people fail to implement these changes (Scottish Executive, 2001). This is particularly so in low-income communities, where lack of confidence and low basic food skills may contribute to a limited intake (McGlone *et al*. 1999). Local food projects to address these and other barriers have developed in deprived areas, but the impact of such interventions on dietary intake and financial factors has not been studied in detail.

The aim of the CookWell project was to develop and implement a transferable, community-based, food skills programme and evaluate its impact on the diet quality of participants and their families and on household food expenditure.

The programme, consisting of an informal, educational introductory session and seven weekly cookery sessions (for the intervention group), took place at eight locations throughout Scotland. Recruitment was undertaken by local community workers, and participants were divided into intervention (I) and delayed intervention (DI) groups. Data collection took place immediately pre-(T1) and post-intervention (T2) and 6 months (T3) later. A 7 d estimated food diary was used to assess changes in diet, while confidence in cooking and methods of food preparation were assessed using a self-administered questionnaire.

Of ninety-three participants, fifty completed 7 d food diaries at T1 and T2; of these only forty completed diaries at T3. These were analysed to measure changes in weekly portions of key foods targeted in the programme. Food diaries at T1 and T3 showed that fruit consumption was very low (mean, two portions per week) in this group of low-income consumers but between T1 and T2, significant changes were found for fruit intake and non-significant increases for vegetables and salad intake. Intakes of fish, and rice and pasta were unchanged.

Foods	Group I (*n* 29) Group DI (*n* 21)	Mean portions per week T1	Mean portions per week T2	Mean change T2 – T1	Standard deviation	Significance (2-tailed)*
Fruit	I	1.7	2.7	1.03	2.260	0.047
	DI	2.3	2.1	−0.24	2.071	
Vegetables & salad	I	6.0	6.4	0.45	3.690	0.476
	DI	7.1	6.6	−0.43	4.956	
Total fruit & vegetables	I	7.8	9.5	1.72	4.705	0.180
	DI	9.8	9.5	−0.33	5.986	
Fish	I	1.0	1.2	0.21	1.206	0.962
	DI	1.1	1.3	0.19	1.167	
Pasta & rice	I	2.1	1.9	−0.21	1.800	0.121
	DI	2.0	2.7	0.67	2.105	

* Student's *t* test for difference between change in intervention versus change in delayed intervention group.

Between T1 and T3 there was a significant increase, from 67% to 90%, in the percentage of intervention subjects reporting confidence in following a recipe (P= 0.044) and a small but not significant increase in confidence in cooking from basic ingredients (P=0.06) and cooking lentil soup (P=0.07). In contrast, the delayed intervention group showed little or no increase in confidence. CookWell had a small, immediate beneficial impact on participants' diets which was not sustained, but there appears to be a more lasting impact on participants' confidence which in time may assist dietary change.

Funding from the Food Standards Agency is gratefully acknowledged (Project G069).

McGlone P, Dobson B, Dowler E & Nelson M (1999) *Food Projects and How They Work*. York: Joseph Rowntree Foundation.
Scottish Executive (2001) *The Scottish Health Survey*. Edinburgh: HMSO.

The impact of a community-based practical food skills intervention (CookWell) on assisting dietary change: qualitative findings. By W.L. WRIEDEN[1], M. STEAD[2], M. CARAHER[3], P.J. LONGBOTTOM[1], K. VALENTINE[1] and A.S. ANDERSON[1], *[1]Centre for Public Health Nutrition Research, University of Dundee, Ninewells Hospital and Medical School, Dundee DD1 9SY, [2]Centre for Social Marketing, University of Strathclyde, 173 Cathedral Street, Glasgow G4 0RQ and [3]The Centre for Food Policy, Thames Valley University, 32–38 Uxbridge Road, Ealing, London W5 2BS*

Food choice in low-income communities may be limited by a range of factors, including cost, access, cultural norms, and low confidence and skills in food preparation (Scottish Office, 1996). The 'CookWell' intervention comprised a 7-week programme of cooking skills classes, delivered in community settings in eight low-income communities across Scotland. The programme was developed using a community development approach, with focus group discussion being held with prospective participants in two of the areas. A longitudinal controlled study examined the intervention's impact on food intake and expenditure, while complementary qualitative research (with participants who had experienced the intervention) examined a range of issues relating to the intervention and also to wider, social and psycho-social benefits, including confidence, social interaction and community participation. Two researchers carried out a total of 32 in-depth interviews with subjects who completed the CookWell programme. These were recorded, transcribed and analysed thematically by the interviewer who gave the results to the other researcher for methodological triangulation.

Formative research suggested that popular topics included soups and budget cookery, but that interest in fish and vegetables was low. Using this information, a CookWell manual was designed to enable facilitators to follow a standardised, but flexible, programme in each community. In addition three groups were identified as 'confident', 'basic but fearful', and 'disempowered' cooks.

Post intervention, participants reported an increase in their personal confidence and pride, an increased likelihood of tasting and experimenting with new foods with a wider repertoire of dishes being prepared, facilitation of new skills (e.g. cutting up a cauliflower, making white sauce), an increased awareness of food preparation and production, and changes in shopping behaviour (e.g being prepared to buy value ranges, spices, herbs and other basic ingredients). Personal benefits such as participants having time for themselves to learn the new skills were appreciated, with the importance of a separated crêche with familiar workers being cited as crucial to the attendance of participants with young children. Participants also reported barriers to changing food intake at home, including time, demands of looking after young children, taste preferences of family members, and dented confidence if a recipe did not turn out as expected. In summary, the qualitative data showed that CookWell delivered on a number of levels, namely specific cooking skills, confidence and enjoyment around food, personal life skills and community capital. An example of a comment post-intervention:

> "*It was ken* (you know)*, just the sort of idea of pulling things together, starting from scratch and saying to yourself 'I made that', and you felt good about it, ken, it was good.*"

Quantitative data (Valentine et al 2002) showed a small impact on actual food choice but qualitative data provided a further insight into the factors that may support short- and long-term changes in dietary intake.

Funding from the Food Standards Agency is gratefully acknowledged (Project G069).

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Valentine K, Longbottom PJ, Wrieden WL, Anderson AS & Dowler E (2002) *Proceedings of the Nutrition Society* (In Press).

A Yerba maté based supplement, MetRx BetaPHos, increases postprandial energy expenditure.

By Y. VAN GAMEREN, L. V.D. BURGT, R. RAGGERS and C. VERDUYN, *Department of Nutritional Supplements, Sports & Consumer Diets, Numico Research B.V., Wageningen, The Netherlands*

Increasing energy expenditure is helpful in the treatment of overweight and obesity. Yerba maté is a stimulant beverage widely consumed in South America and traditionally used for various health benefits. In this study we evaluated the effect of MetRx BetaPHos, a Yerba maté containing supplement, on energy expenditure in healthy volunteers. In addition, we assessed the safety of this particular supplement.

Thirthy-seven healthy male volunteers participated in this randomised, placebo-controlled, double-blind, cross-over study. Both supplement and placebo were given in combination with a standard breakfast, with a washout period of 7 days between measurement days. Postprandial changes in energy expenditure (EE), respiratory quotient (RQ), blood pressure (BP) and heart rate (HR) were followed for 4 h. EE and RQ were measured using a ventilated hood system (Sensormedics, Vmax29 series). Within-subject differences were analysed using ANOVA. Administration (with meal) of the supplement increased EE significantly higher than placebo (0.55 (SE 0.05) KJ/min *v.* 0.38 (SE 0.05) KJ/min; compared to baseline). The data demonstrates that the supplement increased dietary-induced thermogenesis by 42%. The increase in EE reached significantly higher levels for the supplement after 160 min (Figure 1). This corresponds with a study by Martinet *et al.* (1999), in which a delayed thermogenic response with Yerba maté extract was observed. Both the supplement and the placebo showed minimal changes in RQ (0.006 (SE 0.009) *v.* -0.004 (SE 0.008)). No marked changes in HR were found after supplement and placebo (2.9 (SE 0.6) *v.* 4.0 (SE 0.8) BPM). A significantly higher, but clinically normal, increase in systolic BP was seen after the supplement compared with placebo (5.6 (SE 0.9) *v.* 1.8 (SE 1.4) mmHg). The mean peak heights were 132.4 (SE 1.6) and 129.4 (SE 2.1) mmHg for supplement and placebo, respectively. The diastolic BP did not show significant changes after supplement compared with placebo (1.1 (SE 0.7) mmHg *v.* –0.3 (SE 0.8) mmHg), and peak heights were comparable for both groups (80.8 (SE 1.0) *v.* 79.4 (SE 1.3) mmHg).

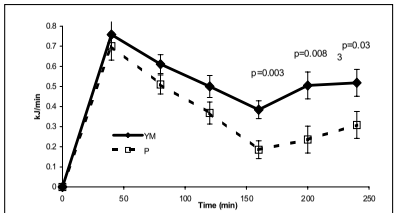

Figure 1. Change in EE response over time in both groups (mean ± SEM)

MetRx BetaPHos, containing Yerba maté, significantly increases EE as compared with placebo, with no marked effects on BP and HR. This Yerba maté based supplement may be feasible as a weight-loss aid.

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The influence of moderate red wine consumption on antioxidant status and on indices of oxidative stress relevant to coronary heart disease in healthy volunteers.

By C. TSANG[1], S. HIGGINS[2], G. DUTHIE[3], M.E.J.LEAN[4] and A. CROZIER[1], [1]*Plant Products and Human Nutrition Group, Division of Biochemistry and Molecular Biology, University of Glasgow, G12 8QQ* [2]*Department of Human Nutrition, University of Glasgow ,G3 8SJ* [3]*Rowett Research Institute, Bucksburn, Aberdeen, AB21 9SB,* [4]*Department of Human Nutrition, University of Glasgow, G2 2ER*

Moderate red wine consumption is inversely related to CHD, an association popularised as the 'French Paradox' (Renaud & de Logeril, 1993). The protective effects have been attributed to phenolics contained in red wine originating from grape seeds, skins and vine stems. Phenolics have been shown to act as potent antioxidants in *in vitro* studies by reducing damaging free radical reactions (Burns *et al*. 2000). A randomised, controlled study was performed with twenty-three healthy volunteers. Subjects in the intervention group consumed 375 ml/d red wine (Safeway's Bulgarian Cabernet Sauvignon, 1999, 12% alc/vol, 2400 mg/l polyphenols) for 2 weeks. Fasting blood samples were obtained at baseline and following the intervention period. Plasma antioxidant capacity and concentrations, conjugated dienes and TBARS (Thio Barbituric Acid Reactive Substances) produced in copper-oxidised LDL and fasting plasma lipids were determined.

	Intervention group (*n* 12)				Control group (*n* 8)			
	Baseline		Week 2		Baseline		Week 2	
	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
AOX capacity (% Fremy's radical reduced/l)	37.4	2.5	40.5	3.3	35.3	1.8	34.0	2.3
Total phenolics (mg/l gallic acid)	2079.0	124.0	2814.0† ***	141.0	2018.2	43.3	2227.1	124.8
α-Tocopherol (μmol/l)	10.9	0.8	10.0	0.4	10.0	0.4	9.2	0.4
γ-Tocopherol (μmol/l)	0.4	0.1	0.5	0.1	0.5	0.0	0.4	0.0
Retinol (μmol/l)	0.7	0.0	0.7	0.0	0.6	0.0	0.6	0.0
Total carotenoids (μmol/l)	0.9	0.1	0.8	0.1	0.9	0.1	0.8	0.1
Ascorbic acid (mmol/l)	68.8	5.7	64.0†	7.1	46.7	9.6	47.7	16.4
Max diene concentration (nmol/mg LDL protein)	853.9	67.1	714.7*	53.4	859.8	7.7	867.8	130.5
Max oxidation rate (nmol/mg LDL protein)	8.7	1.1	7.4	0.6	9.3	2.3	8.4	0.1
Lag phase (min)	43.1	4.0	49.6	3.2	46.0	14.2	46.4	12.7
TBARS (nmol/mg LDL protein)	69.1	8.3	50.5*	5.6	59.0	12.2	62.4	9.9
Total cholesterol (mmol/l)	4.5	0.3	4.9	0.3	4.2	0.4	4.1	0.3
Triacylglycerol (mmol/l)	0.8	0.1	0.9	0.1	0.8	0.2	0.7	0.1
HDL cholesterol (mmol/l)	1.4	0.1	1.5*	0.1	1.5	0.2	1.4	0.1
LDL cholesterol (mmol/l)	2.7	0.2	2.9	0.2	2.4	0.3	2.4	0.3

Mean values were significantly different from baseline: $^{*}P \leq 0.05$, $^{***}P \leq 0.001$ (paired *t*-test). Significantly different from control: † $P \leq 0.05$ (2 sample t test)

The table shows that moderate daily intake of red wine for 2 weeks significantly increased plasma total phenolics ($P<0.001$) and HDL-cholesterol concentrations ($P<0.05$), and significantly reduced the maximum concentration of conjugated dienes ($P<0.05$) and TBARS ($P<0.05$) produced. No changes in any of these parameters were observed in the control group. Plasma total phenolics were significantly greater in the intervention group ($P<0.05$).

The findings from the present study provide some evidence for biological effects following moderate red wine consumption.

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Total body water = 7.4 × height cubed: a simple formula to aid quality control and economic tracer use in studies of body composition and total energy expenditure in children and adults. By C. SLATER[1] and T. PRESTON[2], [1]*Department of Child Health, University of Glasgow, Yorkhill Hospitals, Glasgow G3 8SJ and* [2]*Isotope Biochemistry Laboratory, Scottish Universities Environmental Research Centre, East Kilbride G75 0QF*

The principal method of measuring total body water (TBW) is by isotope dilution. The doubly-labelled water method remains the method of choice for measuring total energy expenditure (TEE) in free-living individuals, but ^{18}O is scarce and expensive. It is therefore important to optimise tracer use by tailoring doses to the individual subject. TBW was measured in 261 subjects (135 males and 126 females) aged from 3 to 87 years, including healthy children, children with HIV, and adults with NIDDM, mild hypertension, pancreatic cancer, and lung cancer, either in studies of body composition (Lean *et al*. 2001; Preston, 1997) or TEE (Moses *et al*. 2001; Preston *et al*. 2001; Reilly *et al*. 2001).

A linear relationship was found between TBW and height in all subjects. When TBW is plotted against height cubed (Ht^3, m^3) the regression line can be forced through the origin. For adults of BMI (18.5> BMI<29.9) and all children, this yields: TBW (litres) = 7.40 × Ht^3, R^2=0.95, n=220. Absolute errors are greater at higher TBW, but use of a $\log_{10}$ transformation reduced this effect, when the residuals were plotted against TBW (Bland & Altman, 1986). This simple linear relationship between measured TBW and Ht^3 was compared with other prediction methods: (1) TBW = 55% body weight (ICRP, 1975); (2) TBW predicted from height and weight (Hume & Weyers, 1971); and (3) TBW calculated from bioimpedence (BIA) data in 108 subjects (26 adults and 82 children).

TBW prediction method	Mean difference*	SEM	95% CI
TBW = 7.4×Ht^3	0.55	0.22	0.11, 0.99
TBW = 0.55×body weight	–1.95	0.28	–2.51, –1.40
Hume & Weyers	–1.20	0.26	–1.70, –0.69
BIA (n=108)	–2.12	0.22	–2.55, –1.69

*Measured TBW minus predicted TBW for all 261 subjects, unless stated otherwise.

In such a range of subjects, including children and obese and wasted adults, it is unsurprising that prediction assuming a constant fraction of body water, or using a formula derived in adults, both fail. Tracer dosage could be estimated from BIA measurements (Preston *et al*. 2001). However, a major part of TBW estimation by BIA is explained by the relationship of TBW with Ht^2. To target tracer dosage, there is little or no advantage in using BIA measurement over TBW prediction from Ht^3. This simple relationship of TBW with Ht^3 is too crude to be used as a body composition predictor in individual subjects. However, it can be used as a QC tool to identify gross errors. Here, use of a $\log_{10}$ transformation and residual plot can serve to identify outliers. Finally, for epidemiological studies, lean body mass (LBM) may be estimated from TBW: LBM (kg) = 10.1 × Ht^3. Similarly, body fat (%) = 100–(1010×Ht/BMI).

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Association between cognitive restraint and food intake in a sample of Portuguese university students. By P. MOREIRA[1], D. SAMPAIO[2] and M.D.V. ALMEIDA[1], [1]*Faculty of Nutrition and Food Sciences, University of Porto, R. Roberto Frias, Porto, Portugal and* [2]*Faculty of Medicine, University of Lisboa, Alam. Egas Moniz , Lisbon, Portugal*

The desire to control food intake in order to avoid weight gain or to lose weight is widespread among university students (Baptista *et al*. 1996). This raises some concerns because food restriction is likely to have a potentially negative impact on health (French & Jeffery, 1994). However, evidence regarding the association between cognitive restraint and dietary intake is conflicting (French & Jeffery, 1994). Some of the factors that may explain this inconsistency are the lack of valid data about the methods used to measure food consumption, or the inadequate choice of methods (such as diet records) used to assess dietary intake. The main objective of this study was to determine whether students with high restraint behaviour differ from low-restraint students in relation to dietary intake, using questionnaires specially adapted and validated for university students.

The study was divided into three phases. In the first phase, after obtaining permission from the authors, we translated and adapted the “Three-Factor Eating Questionnaire” (TFEQ; Stunkard & Messick, 1985), and studied the construct validity of the scale with a sample of 194 students from the University of Porto (UP) (97 female, 97 male). Factorial loadings and eigenvalues for each factor (restraint, disinhibition and hunger), correlation patterns, and reliability for subscales, seemed to be adequate.

In the second phase, the relative validity of a semi-quantitative food-frequency questionnaire (FFQ) developed and validated for Portuguese adults (Lopes *et al*. 1998) was assessed by comparing nutrient intake (energy and 44 nutrients) obtained with the FFQ with the nutritional data from a 4 d diet record. Subjects in this study were 247 students from UP (160 females, 87 males). The results suggested that this FFQ provides good estimates of intakes, comparable to those reported from other studies in the literature.

In the last phase, a sample of 380 students (60% female, 40% male) from UP, scoring high and low on measures of dietary restraint and disinhibition, as measured by the TFEQ, was studied. Dietary intake was obtained using the FFQ described above. Smoking habits, anthropometric and physical activity data were also collected. The association of restraint and disinhibition with nutritional and dietary variables was tested using multivariate analysis of variance (MANOVA) in a 2 × 2 factorial design (high/low restraint × high/low disinhibition). Dependent variables were energy, nutrients, and food intake. The MANOVA for nutritional and dietary data found significant main effects for restraint. Effects were further analysed using univariate analysis of variance (ANOVA). Effects due to dietary restraint exhibited a different pattern in each sex, namely for energy consumption. When comparing high and low restraint groups, among women, high restrainers reported lower consumption of energy (2062 Kcal versus 2208 Kcal, $p < 0,01$), pastry (45 g versus 64 g, $p < 0,05$), bread/cereals/pulses (303 g versus 323 g, $p < 0,05$) and higher consumption of vegetables (149 g versus 112 g, $p < 0,01$), and sea food (85 g versus 64 g, $p < 0,001$), than low restrainers, even after adjustment for potential confounders (energy, body mass index and physical activity). In male subjects, high restrainers consumed significantly more vegetables than low restrainers (128 g versus 55 g, $p < 0,05$). These results emphasise the association between high restraint behaviour and lower reported energy consumption in women, but not in men, and a generally better food pattern in males and females from the high restraint groups.

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Changes in total energy expenditure in a representative sample of young children: cross-sectional and longitudinal analysis. By C. MONTGOMERY[1], L. KELLY[1], D.M. JACKSON[2], J.J. REILLY[1], S. GRANT[3] and J.Y. PATON[4], [1]*University of Glasgow Department of Human Nutrition, Yorkhill Hospital, Glasgow G3 8SJ,* [2]*Division of Appetite and Energy Balance, Rowett Research Institute, Aberdeen AB21 9SB,* [3]*Institute of Biomedical and Life Sciences, University of Glasgow, Glasgow G12 8QQ and* [4]*University of Glasgow Department of Child Health, Yorkhill Hospital, Glasgow G3 8SJ*

No studies have examined total energy expenditure (TEE) or changes in TEE over time in representative samples of young children. The present study was the first longitudinal assessment of TEE in a representative sample of young children, and the largest study using doubly labelled water (DLW) in children of any age to date. We measured TEE by DLW in a socio-economically representative sample of seventy-eight 3-year-old children (mean age 3.7, SD 0.5) in 1999, and in sixty-nine 5-year-olds (mean age 5.8, SD 0. 5) in 2001. Of these children, thirty-nine had TEE measured at age 3.7 and 5.8 years (twenty-four boys), allowing changes in TEE to be described both longitudinally and cross-sectionally. TEE was calculated using the two-point method and equation A6 from Schoeller *et al*. (1986). Resting energy expenditure was measured (mREE) in twenty children at age 5.8 years ;predicted resting energy expenditure (pREE) was estimated from Schofield (1985) for all children at 3.7 years and for 19 children at 5.8 years. Estimated average requirement (EAR) was also calculated (DoH, 1991). Physical activity levels (PAL) were calculated as TEE/mREE or TEE/pREE. Longitudinal changes were tested for significance by paired *t*-test or Wilcoxon signed rank test, and gender differences by two-sample *t*-test or Mann-Whitney test. As expected, there were significant increases in body weight ($P<0.001$) and height ($P<0.001$) between the two measurement times. There were no significant changes in BMI or BMI standard deviation score (BMI SDS) between measurements. Mean TEE increased significantly with age (Table). This change in TEE with age was attributable to a significant increase in TEE in boys (mean 5.7 (SD 1.1) *v*. mean 7.1 (SD 1.1) MJ/d) but not in girls (mean 5.5 (SD 1.5) *v*. mean 5.5 (SD 0.8) MJ/d). As a result, despite no significant gender difference in TEE at age 3.7 years, boys had a higher TEE at age 5.8 years compared to girls ($P<0.001$). When adjusted for weight, TEE decreased with age (Table). Gender differences were observed in TEE/kg at age 5.8 years (boys higher, $P<0.05$), as the decline with age was more pronounced in girls ($P=0.01$). EAR significantly ($P<0.001$) exceeded TEE by a mean of 0.8 MJ/d (95% CI 0.3–1.2) at 3.7 years, and a mean of 0.9 MJ/d (95% CI 0.6–1.2) at age 5.8 years. There was no overall change in PAL with age ($P=0.5$) (Table). PAL increased significantly in boys (median 1.54 *v*. 1.68, $P=0.03$), with boys having a significantly higher PAL at age 5.8, compared with girls. The present study suggests that levels of TEE in contemporary British pre-school children are low compared to EAR. In addition, several age- and gender-related changes in the TEE of young children were observed.

Variable (Mean (SD))	3.7 years	5.8 years	*P*
TEE (MJ/d)	5.6 (1.3)	6.5 (1.2)	<0.001
TEE/kg (kJ/kg)	351 (84)	318 (46)	<0.05
PAL	1.55 (0.35)	1.60 (0.25)	=0.5

Table. Variables at age 3.7 years and at 5.8 years. *P* values obtained by paired *t*-test.

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Early regulation of hypothalamic arcuate nucleus CART gene expression by photoperiod in Siberian hamsters. By J.G. MERCER, C. ELLIS, K.M. MOAR, T.J. LOGIE, P.J. MORGAN and C.L. ADAM, *ACERO, Appetite and Energy Balance Division, Rowett Research Institute, Bucksburn, Aberdeen AB21 9SB*

Siberian hamsters (*Phodopus sungorus*) exhibit a number of adaptive responses to transfer from long photoperiod (long day; LD) to short photoperiod (short day; SD), including large amplitude, reversible changes in body weight/adiposity. Most knowledge of the hypothalamic systems and hormonal feedbacks that regulate body weight is based on rodent studies that have examined responses to imposed energetic manipulations, or models of genetic obesity. In contrast, few data assess the roles and interactions of different components of the signalling array under conditions of dynamic physiologically programmed body weight regulation. Several energy-balance-related neuropeptide and receptor genes exhibit differences in mRNA expression when LD, high body weight, and SD, low body weight, hamsters are compared (Mercer *et al*. 2001; Adam *et al*. 2000). Photoperiod-sensitive genes include proopiomelanocortin (POMC), agouti-related protein (AGRP), cocaine and amphetamine-regulated transcript (CART), leptin receptor (OB-Rb), and melanocortin 3-receptor (MC3R), all expressed in the hypothalamic arcuate nucleus (ARC). Short photoperiod hamsters have elevated CART mRNA in the ARC, suggesting a role for this catabolic/anorexigenic peptide in SD-induced weight loss or growth restriction. The possibility that a change in activity of the CART system could be involved in driving seasonal body weight regulation, as opposed to being a secondary response to that regulation, was strengthened by the observation of an increase in CART mRNA within 14 days of transfer of juvenile female hamsters to SDs (transfer at weaning), and prior to the development of a significant LD–SD weight differential (Adam *et al.* 2000).

To investigate the time course of acute changes in CART gene expression, juvenile female hamsters were weaned into either LDs or SDs and killed at 4, 7, 14 or 21 days post-weaning in either photoperiod. The possibility of sex or age specificity in the early response of the CART system to SDs was assessed in juvenile male hamsters at 14 days post-weaning in either photoperiod, in adult female hamsters held in LDs or transferred to SDs for either 14 or 21 days, and in adult male hamsters held in LDs or transferred to SDs for either 14 or 21 days. Cocaine- and amphetamine-regulated transcript (CART) mRNA and that of a number of other candidate neuropeptide and receptor genes was quantified by *in situ* hybridisation in 20 micron coronal cryostat sections through the hamster hypothalamus using ^{35}S-radioactively labelled complementary riboprobes generated by *in vitro* transcription from cloned cDNAs. Autoradiographic images resulting from probe hybridisation were quantified by image analysis (computerised densitometry).

In these studies, elevated CART mRNA in SD juvenile female animals relative to LD controls was apparent throughout the caudal–rostral extent of the ARC after 14 or 21 days, but was not observed when SD exposure was limited to 4 or 7 days. Elevated CART gene expression was also observed in juvenile males 14 days after transfer to SDs at weaning, in female hamsters 14 days after transfer to SDs in adult life, and in adult male hamsters 21 days after transfer to SDs. Transfer of low-bodyweight, SD adult male hamsters back to LDs for 14 days did not induce a change in CART mRNA in the ARC. There were no consistent trends in expression levels of other energy-balance-related genes with these relatively short duration photoperiod manipulations, suggesting that CART may be involved in photoperiod-programmed body weight regulation.

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The diuretic effect of moderate amounts of ethanol in hydrated and hypohydrated humans. By J.B. LEIPER, J. BREMNER, J. BURNS, S.M. SHIRREFFS and R.J. MAUGHAN, *Department of Biomedical Sciences, University Medical School, Foresterhill, Aberdeen AB25 2ZD*

Ingested ethanol acts as a diuretic by decreasing vasopressin secretion (Eisenhofer & Johnson, 1982), but this action may be attenuated when individuals are hypohydrated by prior exercise in the heat (Shirreffs & Maughan, 1997). In the present study, which was approved by the local ethics committee, seven moderate alcohol drinkers (three males, four females) were dehydrated by a combination of exercise in the heat followed by overnight fluid restriction. Subjects were tested on four separate occasions in the morning at least 12 h after exercising. On two occasions subjects were rehydrated following the dehydrating exercise by ingesting, with their evening meal, a water volume equivalent to twice their exercise-induced sweat loss plus 500 ml before going to bed and 500 ml in the morning 2 h before coming to the laboratory. On both hypohydrated trials, after the dehydrating exercise subjects drank only 100 ml of water with their evening meal and consumed no other liquids before being tested in the morning. The same meals were given to the subjects on all four trials. Each morning, subjects drank, in 30 min, 1000 ml of either a non-alcoholic beer or beer with a 4% ethanol content; each trial was performed in a hydrated and hypohydrated state. Urine samples were collected before ingestion and at hourly intervals for 4 h after drinking finished. All subjects were familiarised with the study procedures before undertaking their first experimental trial; the treatment order was carried out using an incomplete block design. Data were found to be normally distributed and statistical significance ($P<0.05$) was determined using repeated-measures and one-way ANOVA with Tukey's *post-hoc* analysis as appropriate.

Initial mean (SD) body mass (72.5 (11.1) kg) was similar at the beginning of all trials. Immediately before ingesting the test solutions, subjects on both hypohydrated trials were dehydrated to a similar extent (2.1 (0.5)% of initial body mass; mean and SD). Peak urine output was produced 1 h after finishing drinking on all trials. Similar mean (SD) urine volumes were produced at that time on the hypohydrated trials whether subjects drank non-alcoholic (DNA (330 (241) ml)) or alcohol-containing beer (DA (359 (138) ml)); this was less ($P=0.001$) than on the hydrated trials following ingestion of the non-alcoholic (HNA (803 (98) ml)) and alcohol-containing beer (HA (830 (198) ml)), which were essentially the same ($P>0.05$). Cumulative urine output over the 4 h measurement period was similar ($P= 0.24$) on trials DNA (601 (319) ml) and DA (816 (324) ml), but both were less ($P=0.001$) than that on trial HNA (1248 (129) ml), which was less ($P=0.006$) than that on trial DA (1586 (231) ml). Data from this study suggest that ingestion of 1 litre of 4% alcohol has a diuretic effect on well-hydrated individuals, but the effect is blunted in individuals hypohydrated by 2% of their body mass. The lack of an alcohol-induced diuresis in hypohydrated individuals is a consequence of the loss of body water and not to any other effects of exercise.

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Association between macronutrient intake in adolescence, maternal background and dietary beliefs. By P.J. LONGBOTTOM[1], A.S. ANDERSON[1], A.C. WILSON[2], J.S. FORSYTH[2] and S.A. GREENE[2], [1]*Centre for Public Health Nutrition Research, Department of Medicine and* [2]*Tayside Institute of Child Health, Ninewells Hospital and Medical School, Dundee DD1 9SY*

There is a general concern that inappropriate dietary intake in childhood and adolescence may be a contributory factor to diseases of adulthood (Block *et al.* 1992). The aim of this study was to investigate diet and lifestyle factors associated with macronutrient intake in 119 children aged 11 to 14 years (mean age 13.1 years) initially recruited as part of the Dundee Infant Feeding Study (Howie *et al.* 1990).

Nutrient intakes were assessed using the EPIC (European Prospective Investigation of Cancer) food frequency questionnaire (FFQ) administered by a trained interviewer. An adapted self-completed questionnaire was also used to examine lifestyle variables and health and diet beliefs (Sweeting & West, 2000). The Energy Intake (EI):Basal Metabolic Rate (BMR) ratio was calculated and those with a Physical Activity Level (PAL) of under 1.2 or over 2.5 were excluded. Subsequently the group was split into two subgroups according to the median percentage energy from fat (36%). Analysis was carried out using the Mann-Whitney *U*–Wilcoxon rank sum test for non-parametric data and *t*-test for parametric data.

In both groups, intakes of saturated fats and sugars were higher than current recommendations for adults (DoH, 1991). Intakes of macronutrients (apart from protein) were significantly different between the groups, notably in fat and sugar (see below). No significant differences were found in BMI between the subgroups. Median energy intakes were significantly greater in the higher fat group (HFG) ($P=0.017$) with intakes of 11.1 MJ (2648 kcal) (IQR, 2.7[656]) compared with 9.9 MJ (2345 kcal) (IQR, 2.8[677]) in the lower fat group (LFG).

Source of energy	Contribution to food energy intake (%)				
	LFG (*n* 60, 23 males, 37 females)		HFG (*n* 59, 25 males, 34 females)		
	Mean	SD	Mean	SD	
Protein	15.7	2.3	14.7	3.2	
Carbohydrate	51.7	3.5	45.7	4.3	***
Starch	26.6	3.8	24.3	3.6	**
Total sugars	24.1†	6.8†	20.9†	4.8†	***
Total fats	32.6	2.8	39.6	2.7	***
Saturated fats	12.6†	2.3†	15.5†	3.2†	***
Monounsaturated fats	11.7	1.4	14.1	1.4	***
Polyunsaturated fats	5.6†	2.4†	6.7†	2.9†	**

***$P<0.001$, **$P<0.01$ using Student's *t*-test (parametric data) and the Mann-Whitney *U*–Wilcoxon rank sum test (non-parametric data).
† Non-parametric data, therefore median and interquartile range given.

The LFG ate breakfast cereals, salads, cooked vegetables and fresh fruit significantly more often than the HFG. The LFG were significantly more likely to report that it was 'quite' or 'very likely' that they would eat a healthy diet in the future and to agree with the statement that 'eating chips every day will harm you'. Compared to the HFG, the LFG had mothers who left school at a later age and these infants had been breast-fed for a longer period.

In conclusion, this study shows that the LFG have diets that more closely resemble current dietary guidelines for fat (DoH, 1991) than those of the HFG, although there is still considerable room for improvement. Lower fat intakes were also associated with maternal educational background and greater knowledge about contemporary health messages, indicating that parental background and personal beliefs influence dietary choices.

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Estimated percentage body fat and other anthropometric measurements in patients with chronic fatigue syndrome. By C. KELLY and L. WOOD, *School of Biological and Biomedical Sciences, Glasgow Caledonian University, Cowcaddens Road, Glasgow G4 0BA*

Chronic fatigue syndrome (CFS) is characterised by severe physical and mental fatigue with a delayed recovery time, as well as other physical and neuropsychological symptoms including sleep disturbance, low-grade fever, memory and concentration difficulties, headaches, depression, myalgia, arthralgia, and gastrointestinal disturbances (National Task Force on CFS/ME, 1994). Physical and mental fatigue brought on by minimal exertion that varies throughout the course of a day and is not resolved by rest is characteristic of CFS (Shepherd, 1995). Less than 10% of CFS patients make a full recovery and many more remain severely ill for many years or even decades (Joyce *et al.* 1997).

Patients with CFS may be predisposed to obesity, given their low physical activity levels combined with an illness that can last for many years. The current increase in prevalence of overweight and obesity over the past decade in the UK is attributed in large part to environmental factors, particularly a sedentary lifestyle coupled with access to unlimited quantities of food (Scottish Intercollegiate Guidelines Network, 1996). It is therefore reasonable to investigate body mass and composition in people with CFS, particularly as very little data exists.

Estimated percentage body fat measurements (skinfold measurements at four sites, with their sum being used to predict percentage body fat; and bioelectrical impedance – BI) and other anthropometric measurements (weight, height, BMI, waist circumference) were performed on thirteen patients (eight female and five male) fulfilling the criteria for diagnosis of CFS as defined by the CDC (Fukuda *et al.* 1994).

Mean BMI was 26.97kg/m^2 (±1.70) demonstrating that the patients fit into the overweight category. Patients were asked to give details of any weight changes since the onset of CFS. Seven patients (58%) had either gained weight or substantially gained weight. Clearly, CFS has an impact on body weight in some patients.

A waist circumference (WC) greater than 80 cm for women and 94 cm for men reflects a greater risk of coronary heart disease, diabetes mellitus and stroke. Mean WC indicates that CFS patients are at risk of these diseases.

BMI does not give any indication of the amount of excess body fat. Normal percentage body fat is 20–30% for women and 12–20% for men. Over 33% in women and 25% in men indicates obesity (Pi-Sunyer, 2000). The results suggest that patients have a high percentage of body fat.

		Anthropometry		Estimated percentage body fat			
		Waist circumference (cm)		Bioelectrical impedance		Skinfolds†	
		Mean	SEM‡	Mean	SEM‡	Mean	SEM‡
Female	8	80.2	6.3	33.9	3.4	30.7	2.1
Male	5	99.7	7.1	27.6	2.7	26.5	3.2

†Skinfold sites measured: biceps, triceps, suprailiac and subscapular.
‡SEM = standard error of the mean.

In conclusion, lack of physical activity may predispose CFS patients to obesity, as demonstrated in this cohort. Mean BMI was in the overweight category, coupled with a high WC and a mean percentage body fat higher than the desirable range. In this patient population it may not be appropriate to recommend an increase in physical activity to prevent weight gain, however further research on the effect of graded exercise programmes on CFS patients is still needed.

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Assessment of two bio-impedance analysers for measuring body fat composition: effects of biological variation. By M. GHAYOUR[1], G. FERNS[1,2] and A. TAYLOR[1,2], [1]*Centre for Clinical Science and Measurement, School of Biomedical and Life Science, University of Surrey, Guildford GU2 7XH and* [2]*The Royal Surrey County Hospital, Egerton Rd, Guildford GU2 7XX*

Although the health risks of obesity are well known (British Nutrition Foundation Task Force, 1999), its prevalence is rising in the UK and worldwide (Prentice & Jebb, 1995). Bioelectrical impedance measurement devices have recently become widely available. These devices are thought to provide an objective and reliable measure of body fat (Jebb *et al.* 2000), and their use in clinics and by patients is increasing. There are few data on the precision of these instruments, and the biological factors that affect the measurement of bio-impedance (NIH Consensus Statement, 1996).

Fifteen healthy men (age 25–55 years) and fifteen healthy women (age 22–56 years) were recruited from the University of Surrey. Bioelectrical impedance measurements were made using the Tanita-305 stand-on body-fat analyser (Tanita Corporation, Tokyo) and the Roman hand-held body-fat analyser (Bodystat-1500; Bodystat, Isle of Man). Measurements were made four times during the working day: at baseline, after consumption of a meal, after drinking a beverage and following gentle physical activity (climbing stairs). At each time point, these measurements were repeated three times using each device. These investigations were repeated on three separate days to determine variation with time.

The precision of both instruments was good (CV was <1%), and in both cases percentage body fat was significantly higher in women ($P<0.05$). Although there was a good correlation between values obtained by the two devices ($R^2>0.8$, $P<0.0001$), the hand-held device gave results that were consistently higher than the stand-on device in both men and women ($P<0.05$).

The body fat estimates using either device were strongly related to BMI in both men and women ($R^2>0.8$, $P<0.0001$); however, the association with waist : hip ratio was weak ($0.16<R^2<0.31$, $P<0.05$ in males, $P>0.05$ in females).

Both machines were sensitive to physiological factors. With the hand-held device, body fat estimates were affected significantly by the consumption of food or a beverage (by up to 2.6%, $P<0.05$). With the stand-on device, there was a significant decrease in body fat estimation after exercise (by up to 1.9%, $P<0.05$).

Machine	Gender	Baseline	After exercise	After drink	After food
STAND-ON	Male	19.01 ± 6.47	*18.88 ± 6.33	18.97 ± 6.33	19.19 ± 6.19
	Female	27.20 ± 8.02	*26.75 ± 8.14	*26.67 ± 7.94	26.83 ± 7.80
HAND-HELD	Male	20.78 ± 6.07	20.91 ± 6.04	*21.04 ± 6.15	*21.32 ± 6.14
	Female	27.52 ± 6.78	27.61 ± 6.75	*27.94 ± 6.74	*28.06 ± 6.80

*$P<0.05$.

The instruments used for measuring body fat by bio-impedance show good precision and should be suitable for monitoring patients in general practice. However, they appear to be sensitive to physiological factors, such as exercise and food intake with an effect of up to 2.6% on the percentage body fat estimate. The values obtained were also consistently higher for the hand-held machine in both men and women ($P<0.0001$). Hence these measurements should be made under constant conditions, preferably fasted and before exercise, and the same device should be used in following up.

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Assessment of two types of dietary advice given by community dietitians in a clinical setting. By S. DRUMMOND[1], T. KIRK[1], J. JACKSON[2], J. HENDRY[3], S. PANTON[3] and F. GRAY[4], [1]*Centre for Nutrition and Food Research, Queen Margaret University College, Edinburgh EH12 8TS*, [2]*Kilbirnie Health Centre, Kilbirnie KA25 6HP*, [3]*Bridge of Don Clinic, Aberdeen AB23 8LD and* [4]*Shettleston Health Centre, Glasgow G32 7JZ*

In a society where many chronic diseases are diet-related, the role of the dietitian is crucial in promoting beneficial dietary change. For example, advice to reduce dietary fat intake can promote weight loss (Kendall *et al*. 1991), with even modest reductions resulting in reduced health risks (Goldstein, 1992). A recent study by Drummond & Kirk (1998) has shown that advice to reduce dietary fat only was effective in reducing percentage energy from dietary fat, increasing percentage energy from carbohydrate, and resulted in significant passive weight loss in a group of male volunteers. This was not observed in a similar group advised to reduce both fat and sugar. However intervention studies rely on motivated volunteers. In the clinical situation the effect of advice may be different.

This study aims to compare the effect of two types of dietary advice given by community dietitians in a clinical setting on subsequent dietary intake in free-living men with elevated cholesterol levels. The study was conducted within three community dietitians' localities in Scotland. A parallel design intervention study was employed. Subjects were randomly assigned to Group 1: single dietary message to reduce fat only or Group 2: advice to reduce both fat and non-milk extrinsic (NME) sugar. Dietary compliance was assessed by two 4 d food diaries over 8 weeks. Attitudes to the dietary changes were assessed by questionnaire. Subjects (n=20, after removing under-reporters who reported intakes of <1.1 x estimated BMR (Schofield et al 1985), without weight loss) were normal to moderately overweight men.

Dietary analysis	Week 0				Week 4				Week 8			
	Group 1 (11)		Group 2 (9)		Group 1 (11)		Group 2 (9)		Group 1		Group 2	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
MJ/d	9.74	0.4	8.53	0.3	9.24	0.8	8.06	0.8	9.43	0.5	8.43	0.5
% E. Fat	35.3	0.8	36.9	1.7	35.2	1.4	33.1	2.5	36.2	1.2	35.5	1.8
% E. CHO	47.4	0.9	46.0	1.8	47.4	1.6	48.7	1.6	47.2	1.6	47.6	1.8
% E. Starch	27.5	0.8	24.6	0.9	26.8	1.3	23.9[a]	0.7	27.5	1.4	27.1[a]	0.7
% E. NMES	10.0	0.5	11.4[b]	1.2	11.1	1.1	11.6	2.0	10.5	1.3	9.0[b]	1.0

Figures sharing the same superscript are significantly different: [a]P<0.005, [b]P<0.02.

After 8 weeks neither group had significantly reduced percentage energy from fat, or grams of fat, despite receiving advice to do so. However, both groups self-rated fat intakes as being lower at the end of the study than at the start. At 8 weeks, Group 2 had significantly reduced percentage energy from NME sugar and increased percentage energy from starch without significantly changing percentage energy from total carbohydrate. At 4 weeks, Group 2 had significantly reduced their body weight (by 1.0 kg), when they reported a slightly reduced percentage energy from fat. No significant changes in blood cholesterol levels were observed in either group.

The study was limited by the small number of subjects involved. However, it highlights the difficulties involved in administering dietary advice to patients in the clinical situation. Advice to reduce dietary fat was not effective in this group of subjects. Advice to reduce both fat and sugar resulted in a decrease in sugar intake only – perhaps indicating that sugary foods are easier to identify than fatty foods. Both groups rated their fat intake to be lower at the end of the study. This may be a barrier to further dietary advice.

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'Healthy Helpings': helping patients to control their weight. By L. DAVIDSON[1], M.H. REID[1], and M.G. AWRAMENKO[2], [1]*Health Promotions (NHS Grampian), 181 Union Street, Aberdeen AB11 6BB and* [2]*Scottish Council for Postgraduate Medical and Dental Education, Aberdeen University Medical School, Foresterhill, Aberdeen AB25 2XG*

'Healthy Helpings' (HH) was developed and piloted in 1996 by Health Promotions (NHS Grampian) in partnership with GP practices, in response to the 'Scottish Diet Report' (Scottish Office Department of Health, 1993), which highlighted a progressive increase in the prevalence of overweight and obesity. 'Eating for Health: a Diet Action Plan for Scotland' (Scottish Office Department of Health, 1996) recommended that primary care should "place increased emphasis on giving dietary advice to patients, opportunistically and routinely". National guidelines (SIGN, 1996) also recommend that the focus should be on weight maintenance plans incorporating exercise and healthy eating patterns rather than diets for weight loss, and that to achieve greater weight loss overweight people should be seen frequently and in groups with a specially trained person.

The HH programme aims to contribute to weight control, health gain, and the achievement of national dietary targets (Scottish Office Department of Health, 1996). The main objectives are to extend practical health promotion interventions in the primary care setting, to facilitate and support behaviour change in relation to diet and physical activity, and to achieve weight loss in at least 60% of participants completing the course. The total number of participants who have completed the course over a 5-year period is 529. Of these, data are available for 405. The Table shows the percentage of these participants achieving weight loss and making dietary changes. Health professionals can refer overweight patients aged 18–65 years with a BMI >25 to the programme, which is facilitated by state registered dietitians. The 8-week programme consists of weekly 1½-hour sessions at which participants receive information on healthy eating based on the 'Eating for Health' model (HEBS, 1996) and on becoming more active.

Ongoing monitoring and evaluation has continued to be very positive. Feedback from participants indicates that they find the course interesting and informative and the group sessions valuable for maintaining motivation and providing support. Over a 3-year period, 74% of participants reported that HH has enabled them to overcome previous difficulties in losing weight. Primary healthcare teams also value HH, as the programme complements the work that is already occurring within general practice. Overall HH is achieving its aim in that the participants are making and maintaining positive lifestyle and dietary changes.

Information is collated at the beginning, throughout, at the end of the course, and 6 months post-course and is held on a database and is awaiting statistical analysis. The end-of-course data are all self-reported with the exception of the weight loss, which is monitored by the dietitian. All 6-month post-course data are self-reported. The Table shows a summary of the data for a 5-year period.

	No. of participants self-reporting	% lost weight	% maintained weight	% eating more fruit and vegetables	% eating less fat	% being more active
End of course	405	79.3	8.7	75.3	69.8	70.2
6 months post-course	291	41.3	34.5	64.9	62.7	65.3

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The evaluation of a hand-held computerised visual analogue scale rating system for appetite. By E. CRAWFORD[1], J.R. STEPHEN[2], S. WHYBROW[2] and R.J. STUBBS[2], [1]*The Robert Gordon University, Queens Road, Aberdeen AB15 4PH and* [2]*ACERO, Rowett Research Institute, Bucksburn, Aberdeen AB21 9SB*

The Electronic Appetite Rating System (EARS) (Stratton *et al*. 1998) has recently been expanded and updated for use with current Palm and Handspring hand-held computers. This study was conducted to validate the new EARS against the pen-and-paper method in free-living subjects.

Ten men and ten women (age 37 (SD 13) and 32 (SD 9) years, BMI 25 (SD 4) and 20 (SD 7) kg m^{-2}, respectively) were studied on two occasions each lasting a whole day. BMR was measured by indirect calorimetry, and subjects were provided with a medium-fat maintenance diet calculated at 1.6 BMR. Both electronic and paper versions of the three questionnaires were completed. These were: a motivation-to-eat questionnaire, which was completed every hour during the waking day and contained nine questions, a post-meal questionnaire containing three questions, and a sixteen-question end of day questionnaire (EODQ). Subjects also completed a questionnaire on the acceptability of each technique. Pearson's correlations were calculated for each question. Bland & Altman's (1986) test was used to detect bias between the two methods, and *t*-tests were used to compare the mean difference between techniques to zero.

Subjects found the EARS more convenient and easier to use, but more time-consuming, and all but two subjects preferred using the EARS to the pen-and-paper method. Correlation coefficients for post-meal and hourly questionnaires ranged from r^2=67.1 to 86.8, and for the EODQ from r^2=21.5 to 85.4. Bland and Altman analysis suggested bias between the two techniques for some questions (Figs. 1 and 2). The mean difference between the two techniques was significantly different from zero for five of the hourly and one of the EODQ ratings (P<0.05). These were questions that tended to be scored towards the extremes of the range. Subjects tended to avoid using the extremes when using the EARS, thereby constraining the variance in ratings, and resulting in a significant difference in rating between the two methods.

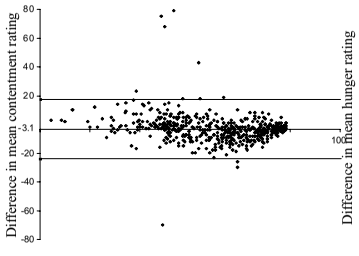

Figure 1 Difference against mean for contentment rating

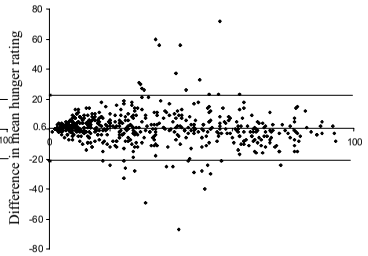

Figure 2 Difference against mean for hunger rating

The new EARS agrees well with the traditional pen-and-paper method of visual analogue scale rating. However, the tendency for bias at the extreme ends of ratings suggests that the two techniques should not be used interchangeably.

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The effects of cage size and activity on mice selected long-term divergently on fatness. By L. BÜNGER and V. CVEJANOVIC, *Institute of Cell, Animal and Population Biology, University of Edinburgh, Edinburgh EH9 3JT*

Divergent selection in mice on fatness for over sixty generations produced a fat (F) and a lean (L) line, with males having about 22% and 4% total body fat, respectively, at 98 d (Bünger & Hill, 1999). To elucidate the importance of locomotor activity for the expression of fatness in this polygenic obese mouse model, different cage sizes, including one with a running wheel, were provided to F-line male mice from generation 62. At 75 d (SD 3) they were assigned to four experimental groups mostly by dividing full-sibs into all four cage size groups (see Table). Nests were scored weekly by two people on a scale of 0–3, with higher values indicating better nests. Body weights (BW) and food intakes (FI) were also measured weekly and all animals were dissected at 139 d (SD 3) after fasting overnight (about 16 h). Body weights and gonadal fat pads (GFP) were weighed and blood glucose was measured with a glucometer (LifeScan, Milpitas, CA). The dry matter weight (DM) of the body was determined by freeze-drying, and fat percentage (fat%) was predicted from the BW:DM ratio (Hastings & Hill, 1989). The amount of body fat and fat-free body weight (ffBW) were estimated from BW and estimated fat%. The main findings were: no significant differences at all (apart from the nesting score, which was higher in the bigger cages) between groups 1 to 3, indicating that the F-line is not sensitive to an almost threefold variation in cage size and that the food hoppers used to minimise spillage did not negatively affect food intake. The provision of a running wheel, however, seems to stimulate enough locomotor activity, even in a genetically obese line, to reduce the fat% level to 12.5%, although FI was significantly increased as well, so that the weight gain over the 9 weeks significantly decreased (being only 1 g in the BC&RW group and 3.6–4.6 g in the other groups). The results demonstrate that these animals with polygenic obesity are still sensitive to high levels of locomotor activity, which can substantially reduce their fat content. The obesity in this mouse line seems not to be accompanied by diabetes, as glucose values were normal in all groups, confirming earlier results, that genetic variation on the $Lepr^{db}$ locus did not contribute to the selection response in the F-line (Bünger *et al*. 2002).

Trait	SC	SC&AF	BC	BC&RW	SE	Group description and notes
BW 75 (g)	39.6^{a}	$39.0^{a,b}$	$38.1^{a,b}$	36.6^{b}	1.02	Experimental groups: **SC** (small cage: 330 cm^2 floor area × 12 cm height); **SC&AF** (as SC but with some of the food from the hopper on the floor, to possibly stimulate additional FI and provide a control for the feeding from the special food hoppers); **BC** (big cage: 960 cm^2 × 12 cm, no running wheel) and **BC&RW** (big cage: 960 cm^2 × 12 cm, plus a running wheel). Shown are least square means with group as a fixed and family as a random effect. The standard errors (SE) were pooled over groups. ^{a,b,c}: Least square means sharing a common character in their superscript are not significantly different (P>0.05).
BW at 139 d	41.0^{a}	40.1^{a}	39.4^{a}	34.7^{b}	1.12	
Glucose (mmol/l)	5.99^{a}	5.95^{a}	5.87^{a}	5.35^{a}	0.38	
Gain 75–138 d	4.62^{a}	4.11^{a}	3.65^{a}	1.12^{b}	0.74	
Fat (%)	18.2^{a}	18.3^{a}	18.2^{a}	12.5^{b}	1.04	
ffBW (g)	33.1^{a}	32.6^{a}	$32.1^{a,b}$	$30.2^{a,b}$	0.59	
Fat (g)	7.89^{a}	7.47^{a}	7.3^{a}	4.48^{b}	0.61	
GFPW (mg)	1525^{a}	1551^{a}	1600^{a}	940^{b}	112	
GFPW (%)	3.24^{a}	3.82^{a}	4.01^{a}	2.65^{b}	0.22	
Fasting loss (g)	3.2^{a}	$2.9^{a,b}$	2.4^{b}	$3.0^{a,b}$	0.24	
Total FI (g)	379^{b}	385^{b}	373^{b}	422^{a}	5.42	
FI (g/d)	6.03^{b}	6.13^{b}	5.95^{b}	6.83^{a}	0.08	
Nest score	1.31^{b}	0.95^{c}	1.68^{a}	1.75^{a}	0.15	

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The effect of different types of exercise on urinary testosterone levels. By E.A.S. AL-DUJAILI, M. CARBONI and A. DELOOY, *Department of Dietetics, Nutrition and Biological Sciences, Queen Margaret University College, Clerwood Terrace, Edinburgh EH12 8TS*

Previous studies have demonstrated that several different exercise protocols result in acute increase (Kraemer *et al*. 1999; Ginsburg *et al.* 2001), decrease (Nindl *et al*. 2001), and no significant changes (Jurimae & Jurimae, 2001) in post-exercise serum concentration of testosterone (T). Others have shown that nutrition and dietary supplementation may also affect T response (Volek *et al*. 1997).

The primary purpose of this study was to investigate changes induced by different types of exercise on 24-h urinary testosterone (T) levels in recreationally active male and female subjects.

Twenty individuals volunteered (thirteen males, seven females) to take part in this study. All participated regularly in recreational exercise of different types (endurance, resistance and mixed) and no changes were made to their normal routine. The mean BMI for males was 25.26 kg/m^2 and for females was 23.65 kg/m^2. Subjects collected a 24-h urine sample on a non-exercise day (9 AM day 1 until 9 AM day 2) and another on the following day (9 AM day 2 until 9 AM day 3).Time of exercise was during day 2 either in the morning, afternoon or evening. Completeness of collection was not checked by estimating the urinary creatinine excretion rate, but there was no marked difference between volumes of urine excreted pre and post exercise in the whole group. Samples were then assayed using the ELISA method to determine 24-h urinary T levels pre-exercise (pre-T) and post-exercise (post-T). Percentage changes pre-T to post-T were calculated.

After exercise, there was a significant increase (P=0.008) from the mean pre-T to post-T for the group as a whole and separately for males (P=0.022) but bordering significance for females (P=0.062).The mean percentage change in urinary T levels (pre-T to post-T) was 53 (SD 78.1) for the whole group; for males, the percentage change was 59 (SD 91), while for females, the percentage change was 41.8 (SD 50.1), with those participating in resistance exercise increasing more than the mixed or endurance exercisers (168.3% *v.* 55.6% and 27.8%, respectively).There was a significant effect of exercise duration on post-T for the group as a whole (P=0.006) with group mean post-T levels being higher for a duration of >60 min. Time of day did not have a significant effect on the T response for the group as a whole. However, males demonstrated a significantly (P=0.012) higher T level after exercise in the morning compared with other times of the day.

Due to the short time period in this study, no detailed analysis of subjects' diets was made. Therefore, it was possible that the composition of individual diets could have influenced the participants' T levels.

The data presented indicate that exercise increases 24-h urinary T levels in recreationally active subjects, and that the type, duration and time of exercise influence the testosterone response. This response appears to be different in males and females.

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Ovine model of obesity: evidence for seasonal and dose-dependent changes in hypothalamic sensitivity to leptin. By C.L. ADAM[1], P.A. FINDLAY[1], M.A. MORRISON[2], N. RAVER[3] and D.W. MILLER[2], *ACERO, [1]Appetite and Energy Balance Division, Rowett Research Institute, Bucksburn, Aberdeen AB21 9SB and [2]Department of Agriculture and Forestry, University of Aberdeen, Aberdeen AB24 5UA and [3]Institute of Biochemistry, Food Science and Nutrition, The Hebrew University of Jerusalem, Rehovot, Israel*

As a ruminant, the sheep has historically not been considered a suitable model for the study of clinical obesity. However, as in humans and rodents, circulating concentrations of the adipose tissue hormone leptin reflect both long- and short-term changes in nutritional status in sheep (Marie *et al*. 2001) and central neuronal targets for leptin in sheep show similar hypothalamic localisations and sensitivity to negative energy balance (Adam *et al.* 2002). One of the features of obesity is the apparent loss of sensitivity to the central anorexic actions of leptin, and we now provide evidence of reversible central leptin insensitivity in sheep that may provide new insights into the underlying mechanisms. Leptin feedback to the hypothalamus plays a role in regulating not only appetite and energy balance regulatory pathways but also the reproductive neuroendocrine axis (Ahima *et al.* 2000). It is not known to what extent these axes share common pathways of leptin action. Hypothalamic reproductive neuroendocrine output (gonadotrophin-releasing hormone, GnRH) is indirectly measured by secretion of luteinising hormone (LH) into the circulation (Clarke & Cummins, 1982). We therefore examined in sheep the simultaneous LH and appetite responses to leptin administered centrally in pharmacological or physiological doses and, since they are seasonal animals, at different times of the year.

In a cross-over design with maintenance-fed oestradiol-implanted castrated male sheep (n=6), responses to single intracerebroventricular (i.c.v., third ventricle) injection of leptin (0.5, 1.0 and 1.5 mg ovine leptin (oLEP) and 1.0 mg murine leptin (mLEP)), NMDA (20 µg) or control (0.9% saline) were measured in terms of LH secretion (every 15 min for 4 h pre- and post-injection) and appetite (2 h post-injection) in the autumn (Expt 1). NMDA and 1.0 mg oLEP treatments were repeated in the spring (Expt 2). Finally, responses to "physiological" i.c.v. infusion of leptin (8 ng/h, 12 h/d for 4 d), insulin (0.7 ng/h) or control (artificial CSF) were measured in spring (n=18 in a cross-over design); LH was measured over 8 h and appetite over 1 h on infusion days 1 and 4 (Expt 3).

In Expt 1 (autumn): oLEP increased LH pulse frequency with negative dose-dependency by up to 110% (P<0.05), decreased LH pulse amplitude (P<0.05), and decreased appetite with positive dose-dependency by up to 35% (P<0.05); mLEP reduced LH pulse amplitude (P<0.05) without significant effect on appetite, while NMDA reduced appetite (P<0.05) with no effect on LH. In Expt 2 (spring): LH responses were 'surge-like' with moving average LH concentration doubled after 1.0 mg oLEP (P<0.001) and after NMDA (P<0.001). The magnitude of the LH response was therefore greater in spring than autumn for both 1.0 mg oLEP (P<0.05) and NMDA (P<0.005). However, unlike in autumn, there was no effect of 1.0 mg oLEP or NMDA on appetite in spring. In Expt 3 (spring): "physiological" i.c.v. infusion of oLEP or insulin increased LH pulse frequency by up to 100% (P<0.001) on days 1 and 4, but there were no effects on appetite.

These results indicate that intracerebral leptin stimulates GnRH and decreases appetite in adequately nourished sheep. However, the responses of both axes are differentially affected by dose rate and by the time of year in this seasonal species, suggesting dissociation of the neural pathways involved. Simultaneous study of both physiological axes will allow elucidation of hypothalamic leptin targets and pathways specifically involved in mediating the separate responses. In particular, the appetite-regulatory circuitry is sensitive to leptin in the relatively short days of autumn but insensitive to leptin in the longer days of spring. Sheep kept in long days therefore provide an unexploited model of obesity, and the fact that their leptin insensitivity is reversible upon shortening the daylength provides a tool with which to elucidate the underlying mechanisms.

Study approved by local Ethical Review Process and funded by the Scottish Executive Environment & Rural Affairs Dept.

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Effects of 7 days of detraining on serum leptin and hunger-satiety measures in endurance-trained men. By F. TSOFLIOU[1], D. MALKOVA[1], C. McALLISTER[1], Y.P. PITSILADIS[2], M. WALLACE[3], M.E.J. LEAN[1] and J.M.R GILL[3], [1]*Department of Human Nutrition, University of Glasgow, Glasgow G31 2ER,* [2]*Centre for Exercise Science and Medicine, University of Glasgow, Glasgow G12 8QQ and* [3]*Department of Pathological Biochemistry, University of Glasgow, Glasgow G31 2ER*

As a result of reduced total body fat, endurance-trained individuals have lower circulating leptin concentrations compared with sedentary subjects but, nevertheless, are able to finely regulate energy balance (Leal-Cerro *et al*. 1998). The precise role, however, of circulating leptin levels on energy balance regulation has not been determined in this population. The following study was designed to investigate whether a period of short-term detraining would influence appetite sensations and circulating leptin concentrations in a group of endurance-trained individuals. Eight endurance-trained athletes (age: 28 (SD 12) years, BMI: 23.6 (SD 1.0) kg m^{-2}, percentage body fat: 17.0 (SD 3.3) %) consumed a 4.5 MJ meal 12 h after fasting during training and after 7 d of detraining. On both occasions, hunger-satiety sensations (Flint *et al.* 2000) and serum leptin concentrations were measured in the fasted state and at selected intervals for 6 h following meal ingestion. Statistical analysis of the data was carried out using 2-way ANOVA for repeated measures followed by Wilcoxon signed rank test. Statistical significance was declared when $P<0.05$. Compared with the training condition, serum leptin concentrations were significantly higher in the detrained condition in the fasting state (at 0 min) and at all time points after the meal (see Table). In contrast, subjective ratings of hunger and satiety did not differ between conditions. Immediately following the meal on both occasions, there was a marked reduction in sensation of hunger and, correspondingly, a marked increase in satiety.

Serum leptin concentrations (ng ml^{-1}) during the fasted state and selected intervals following meal ingestion.

Condition	Time points						
	0 min	30 min	60 min	90 min	120 min	240 min	360 min
Training	2.1	1.9	1.6	1.7	2.0	1.8	1.85
	(0.8-8.2)	(1.0-7.3)	(0.7-7.5)	(0.8-10.2)	(1.0-9.3)	(0.6-8.4)	(1.2-10.9)
Detraining	3.1	3.2	3.25	2.9	3.0	3.25	3.3
	(0.8-11.6)*	(1.7-10.9)*	(1.2-11.4)*	(0.9-12.6)*	(1.3-11.3)*	(1.2-13.1)*	(1.5-11.3)*

Values are median (range); * indicates significant differences from the training condition, $P<0.05$.

In conclusion, a 7 d period of detraining induced an increase in serum leptin concentrations, but had no effect on fasting and post-meal hunger-satiety ratings in endurance-trained individuals. These results, therefore, suggest that removing an acute exercise stimulus may alter the biological regulation of appetite or, alternatively, that leptin may not have a regulatory role in appetite-hunger sensations in endurance-trained men.

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Alterations in nutrient partitioning: a consequence of a high-energy (HE) diet. By Z.A. ARCHER, D.V. RAYNER and J.G. MERCER, *Appetite and Energy Balance Division, Rowett Research Institute, Aberdeen AB21 9SB*

The incidence of obesity, with its associated health risks, is on the increase throughout the western world, affecting all age groups, including children. The typical western diet is high in fat and sugar and low in complex carbohydrates. This study looks at the effects of feeding an equivalent high-energy (HE) diet to growing rats. The HE diet consists of 48% Purina Lab Chow No. 5001, 44% sweetened condensed milk, and 8% corn oil, containing 18.9MJ/g (4.5 kcal/g), with 15% as protein, 33% as fat and 52% as carbohydrate, of which 30% are starches (Research Diets, New Brunswick, NJ, USA). The control diet consists of Purina Lab Chow No. 5001, containing 14.0MJ/g (3.34 kcal/g), with 23% as protein, 12% as fat and 65% as carbohydrate, which is primarily in the form of complex polysaccharide (PMI Nutrition International, Nottingham, UK).

Experiment 1: Eighty male out-bred Sprague-Dawley (SD) rats (125.5 g (SE 0.46)) were kept at 22–23°C on a 12:12 h light-dark cycle and fed chow *ad libitum* (AL) for 8 d then divided into four weight-matched groups (twenty per group). Group A was fed chow AL for 21 d; then ten animals were transferred to HE AL for 14 d. The remaining ten acted as chow controls. Groups B, C and D were fed chow AL for 35 d then ten animals from each group were transferred to HE AL for 12 h (group B), 24 h (group C) or 48 h (group D). Ten animals per group remained on chow. All animals were then killed, their blood sampled and adipose tissue (AT), liver and testes dissected and weighed.

Experiment 2: Sixty male out-bred SD rats (55.1 g (SE 0.32)) were kept at 22–23°C on a 12:12 h light-dark cycle and fed lab chow AL for 7 d. On day 7, rats were divided into two weight-matched groups: thirty rats remained on chow AL; while thirty were transferred to HE diet AL. All animals were killed on day 41, their blood sampled and adipose tissue and muscle dissected and weighed.

Experiment 1: Within each group (A–D), weight gain, liver and testes weights were unaffected by diet. However, in group A, adipose tissue weight was greater in HE than C animals after 14 d (interscapular brown adipose tissue (IBAT) 0.4 g (SE 0.03) *v.* 0.2 g (SE 0.03), $P<0.001$; retroperitoneal 5.6 g (SE 0.55) *v.* 3.9 g (SE 0.39), $P<0.01$; epididymal 6.1 g (SE 0.52) *v.* 4.3 g (SE 0.34), $P<0.01$; omental 0.5 g (SE 0.07) *v.* 0.3 g (SE 0.03), $P<0.01$; mesenteric 4.4 g (SE 0.31) *v.* 3.2 g (SE 0.27), $P=0.01$). In group D, AT weight tended to be higher in HE than C animals (IBAT 0.3 g (SE 0.02) *v.* 0.2 g (SE 0.02), $P=0.08$; retroperitoneal 4.6 g (SE 0.39) *v.* 3.4 g (SE 0.45), $P=0.06$; epididymal 4.6 g (SE 0.27) *v.* 3.8 g (SE 0.27), $P=0.06$). AT depots were unaffected by diet in groups B and C.

Experiment 2: Weight gain was greater in C than HE animals (333.7 g (SE 4.38) *v.* 315.2 g (SE 7.52), $P<0.05$). Interscapular brown AT and total white AT was lower in C than HE rats (0.3 g (SE 0.01) *v.* 0.6 g (SE 0.11), $P<0.01$; 15.4 g (SE 0.53) *v.* 23.1 g (SE 1.61), $P<0.001$, respectively). Gastrocnemius muscle was higher in C than HE rats (4.56 g (SE 0.07) *v.* 4.32 g (SE 0.08), $P<0.05$). Circulating leptin and insulin concentrations were lower in C than HE animals (9.1 ng/ml (SE 0.37) *v.* 23.1 ng/ml (SE 1.50), $P<0.001$; 25.2 μIU/ml (SE 1.81) *v.* 34.5 μIU/ml (SE 2.22), $P<0.01$, respectively).

On casual observation and based on weight-gain alone the HE diet does not appear to cause obesity. However, the HE diet alters nutrient partitioning, favouring fat storage in adipose tissue (increasing lipogenic activity) over synthesis of lean tissue. This increase in adipose tissue is evident in just 48 h; initially favouring IBAT, retroperitoneal and epididymal depots. The increased adipose tissue consequently increases circulating leptin and insulin concentrations. The excessive accumulation of fat tissue on a diet such as that examined here, and its mechanistic underpinning, may be of relevance to the obesity problem currently facing the western world.

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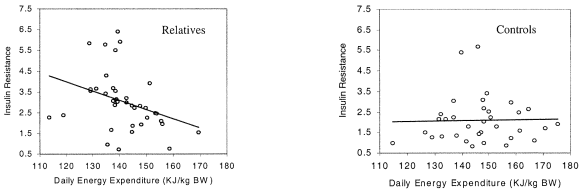
Insulin resistance and environmental risk factors in females with high and low risk of developing type-2 diabetes. By S. HIGGINS[1], J.M.R. GILL[2], R. JANILIONYTE[3], M.J. CASLAKE[2], C.J. PACKARD[2], M.E.J. LEAN[1] and D. MALKOVA[1], [1]*Departments of Human Nutrition and* [2]*Pathological Biochemistry, University of Glasgow, Glasgow G31 2ER and* [3]*Lithuanian Academy of Physical Education, Kaunas 3000, Lithuania*

Environmental factors, such as the high prevalence of obesity and physical inactivity, are likely to be key determinants of the increasing incidence of type-2 diabetes (Narayan *et al*. 2000). First-degree relatives of patients with type-2 diabetes have an increased risk of developing the disease, and insulin resistance is the best predictor of the risk elevation (Kobberling *et al*. 1985). The purpose of this study was to establish the extent to which insulin resistance is influenced by enviromental risk factors in individuals at high risk (first-degree relatives) and low risk (individuals with no family history of diabetes) of developing type-2 diabetes. Fasting plasma glucose and insulin concentrations and anthropometric measurements were analysed in forty female, first-degree relatives of type-2 diabetics (38 (SD 7) years) and thirty-eight female control subjects (39 (SD 7) years) who also completed a 7 d physical activity diary. Insulin resistance was estimated using HOMA (Matthews *et al*. 1985). The compendium of physical activities, which classifies activities by their rate of energy expenditure, was used to estimate average daily energy expenditure – an estimate of physical activity levels (Ainsworth *et al*. 2000). Comparisons between physical characteristics and insulin resistance between groups were tested using unpaired *t*-tests. Analysis of relationships between percentage body fat, waist : hip ratio, daily total energy expenditure and insulin resistance were carried out using Pearson's product-moment correlation coefficients. Data are presented as means (with SD in parentheses).

Body weight (73.4 (11.5) *v*. 66.5 (8.8) kg, $P<0.05$), body fatness (36.9 (6.8) *v*. 32.4 (5.2) %, $P<0.001$), waist : hip ratio (0.80 (0.06) *v*. 0.77 (0.06), $P<0.02$) and insulin resistance (3.0 (1.4) *v*. 2.1 (1.1), $P<0.05$) were all significantly higher in first-degree relatives of type-2 diabetics compared with controls. Daily energy expenditure was similar in both groups (141.6 (10.5) in relatives and 146.5 (12.9) in controls; kJ kg^{-1} body mass). There were significant positive correlations between insulin resistance and percentage body fat in relatives ($r=0.5$, $P<0.001$) and controls ($r=0.5$, $P<0.005$), and between insulin resistance and waist : hip ratio in relatives ($r=0.4$, $P<0.05$) and controls ($r=0.5$, $P<0.001$). A negative correlation between insulin resistance and daily energy expenditure was found in relatives ($r=-0.3$, $P<0.05$), but not controls (see Figure).



In conclusion, physical activity levels are an important determinant of insulin sensitivity in first-degree relatives of type-2 diabetics and this high-risk group may be particularly responsive to physical activity interventions aimed at reducing the risk of development of type-2 diabetes.

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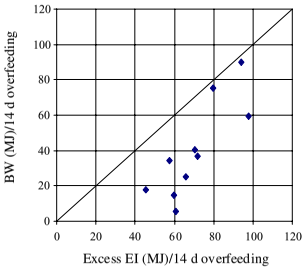
Metabolic response to short-term overfeeding. By A.M.C.P. JOOSEN, A.H.F. BAKKER and K.R. WESTERTERP, *Department of Human Biology, Maastricht University, PO Box 616, 6200 MD Maastricht, The Netherlands*

Overfeeding experiments show considerable interindividual differences in energetic efficiency. Stock (1999) and Dulloo & Jacquet (1999) suggested that overfeeding low-protein diets exaggerates individual differences by maximising diet-induced thermogenesis (DIT). The aim of the present study was to assess the metabolic response to an excess of energy intake by overfeeding a diet relatively low in protein.

Subjects were eleven healthy females, mean age 25 (range 21–36) years, mean body weight 63.3 (range 55.2–77.8) kg and mean percentage body fat 28 (range 18–35) %. They had had a stable body weight for at least 1 year. Three were light smokers. During the baseline period (days 1–8) subjects chose their diets from weighed food packages provided daily for calculation of habitual energy intake. When subjects were not in energy balance, i.e. body weight changed, baseline energy requirements were calculated from basal metabolic rate (BMR) and physical activity level. Subjects were overfed for 14 d at 1.5 times their baseline energy requirements (days 8–22). Overfeeding diets provided 7% of energy from protein, 40% from fat and 53% from carbohydrates. Body weight was measured on days 1, 8 and 22. On days 8 and 22 body composition was determined by using hydrodensitometry and ^2H dilution. BMR was measured by indirect calorimetry using a ventilated-hood system on days 8 and 22. Total energy expenditure (TEE) was measured with doubly labelled water during the 2 weeks preceding overfeeding ($n=6$) and during the 2 weeks of overfeeding ($n=11$).

Data from one subject were excluded because of illness, which we believe was not caused by overfeeding. Excess energy intake (EI), i.e. EI above baseline requirements, was 5.0 (SD 1.2) MJ/d during overfeeding. Body weight increased with 1.33 (SD 0.91) kg ($P=0.001$), fat mass increased with 1.07 (SD 0.81) kg ($P=0.003$). However, changes in body composition were small and near the detection limits of our technique. Increase in TEE (0.55 (SD 0.72) MJ/d) ($n=5$) was not statistically significant. BMR increased by 0.4 (SD 0.5) MJ/d ($P=0.04$). Rise in TEE equals the expected rise in DIT due to the increased amount of food eaten. The Figure shows individual energetic efficiency as the distance to the line for expected energy storage (30 MJ/kg BW). Although some individuals can be defined as energetic inefficient (i.e. a considerable difference between expected and real energy storage), this study shows no evidence for any adaptive energy-dissipating mechanisms.



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Anti-obesity effect of *Dioscorea nipponica* Makino powder in rats. By CHONG-SUK KWON[2], SUNG-HEE KIM[1], JI HYUN KIM[2], KUN HO SON[2] and JONG-SANG KIM[1], [1]*Animal Science and Biotechnology, Kyungpook National University, Taegu, Korea and* [2]*Department of Food Science and Nutrition, Andong National University, Andong, Korea*

Dioscorea nipponica Makino has been used as an oriental medicinal herb for inflammation from ancient times. In the process of screening pancreatic lipase inhibitor, which could be used as an anti-obesity measure, the methanol extract of *Dioscorea nipponica* Makino powder (DP) appeared to have a potent inhibitory activity against porcine pancreatic lipase with 5–10 μg/ml of IC_{50} as assayed according to the method described previously (Kawaguchi *et al*. 1997; Bitou *et al*. 1999) Further purification of active components generated at least five compounds, including diosgenin, dioscin, gracillin, prosaponenin A and C of dioscin (see Table 1). Among those active compounds prosapogenin A showed the strongest inhibitory activity against pancreatic lipase, with 1.8 μg/ml of IC_{50}. Sprague-Dawley rats fed high-fat diets containing 5% *Dioscorea nipponica* Makino and 40% beef tallow gained significantly less body weight during an 8-week experimental period ($P<0.05$) than control animals fed high fat diet alone. Furthermore, the intake of *Dioscorea nipponica* Makino powder significantly reduced the amounts of fat in the epididymis, perirenal and inguinal areas ($P<0.05$), compared with the control rats.

Table 1. Lipase-inhibitory activities of compounds isolated from *Dioscorea nipponica* Makino

	Diosgenin	Gracillin	Prosapogenin A	Prosapogenin C
IC_{50} (ug/ml)	28.0	28.9	1.8	42.2

Table 2. Effect of *Dioscorea nipponica* Makino powder (DP) on body weight and fat gain in lean rats fed AIN-76 diet for 8 weeks

	Body weight gain (%)	Total body fat	Subcutaneous fat	Epididymis fat	Perirenal fat	Inguinal fat
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Control	86.7 (17.6)	38.6 (9.4)	12.9 (2.7)	8.3 (2.0)	6.8 (1.6)	6.5 (2.0)
2% DP	73.5 (8.3)	32.4 (4.7)	11.4 (1.4)	6.8 (1.2)	5.6 (1.0)	5.0 (1.2)
5% DP	65.0 (10.2)*	27.6 (5.5)*	9.8 (2.0)*	5.6 (0.8)*	4.6 (1.3)*	4.8 (1.1)

*Significantly different from control, $P < 0.05$.

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Weight gain in perimenopausal and early postmenopausal women: a result of decrease in physical activity level rather than change in dietary energy intake? By H.M. MACDONALD[1,3], S.A. NEW[2] and D.M. REID[1,3], [1]*Osteoporosis Research Unit, University of Aberdeen, Woolmanhill Hospital, Aberdeen AB25 1LD,* [2]*Centre for Nutrition and Food Safety, School of Biomedical and Life Sciences, University of Surrey, Guildford GU2 7XH and* [3]*Department of Medicine and Therapeutics, University of Aberdeen, Aberdeen AB25 2ZD*

Many women gain weight around the time of the menopause. The aim of this study was to examine whether weight gain depends on menopausal status and HRT use, and to explore whether increased dietary intake or reduced energy expenditure are contributory factors.

The subjects were women from the Aberdeen Prospective Osteoporosis Screening Study (APOSS) on over 5000 women who had a bone mineral density (BMD) scan in 1990–1993 and again in 1997–2000 (6.3 years later), with 3883 women returning for the second visit (75.9% response rate). Dietary intake was assessed for 3239 women by food frequency questionnaire (FFQ) (validated using 7 d weighed intake records and markers of antioxidant status (New & Bolton-Smith, 1993; Bodner *et al.* 1998)). The women were weighed at both visits, with no shoes and wearing light clothing, on scales that were calibrated to 0.05 kg (Seca, Germany). Physical activity levels (PAL) were obtained using the Scottish Heart Health Study PA Questionnaire (Tunstall-Pedoe *et al*. 1989). PAL was calculated from the numbers of hours in a 24-h period doing heavy, moderate or light activities and how many hours were spent sleeping or resting in bed. These questions were asked separately for working and non-working days.

As found previously for a subset of 907 women (Macdonald *et al*. 2002), mean weight had increased for all groups of women, regardless of their menopausal status/HRT use. As shown in the Table, for increasing quintile of weight change (percentage change per year), PAL decreased ($P<0.001$) and this was significant after adjustment for most confounders ($P<0.001$) except for current weight ($P=0.17$). Interestingly, there was no significant relationship between weight gain and dietary energy intake. The energy intake to basal metabolic rate (BMR) ratio was 1.39, indicating under-reporting comparable to other studies.

			One-way ANOVA/ANCOVA								
Quintile of weight change (%/year)			Physical Activity Level ANOVA			Adjusted Physical Activity Level[1] ANCOVA			Dietary Energy Intake (MJ) ANOVA		
	Weight difference (SD) (kg)	*n*	Mean	SD	*P*	Mean	SD	*P*	Mean	SD	*P*
Q1	–4.37 (3.91)	647	1.90	0.35		1.89	0.31		8.05	2.42	
Q2	0.31 (0.73)	646	1.84	0.30		1.85	0.31		8.21	2.5	
Q3	2.57 (0.80)	647	1.83	0.30		1.83	0.31		8.07	2.5	
Q4	4.98 (1.34)	647	1.81	0.31		1.81	0.31		8.19	2.45	
Q5	9.81 (3.61)	647	1.74	0.31		1.74	0.31		8.04	2.82	
Total	2.66 (5.34)	3234	1.82	0.32	<0.001			<0.001	8.11	2.54	0.629

[1]Adjusting for age, height, smoking, socio-economic status, and menopausal status/HRT use.

These data suggest that reduced physical activity rather than increased energy intake appears to be a factor in weight gain of women around the time of the menopause.

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Health and lifestyle variables that predict body mass index and body fat distribution in a nationally representative sample of Irish adults. By S.N. McCARTHY[1], P. ROBSON[2], A. FLYNN[3] and M.J GIBNEY[1], *Irish Universities Nutrition Alliance at [1]Trinity College Dublin, [2]University of Ulster at Coleraine and [3]University College Cork*

Energy intake (EI) must equal energy expenditure in order to maintain stable body weight. It is therefore not uncommon that energy and physical activity are frequently cited as predictors of obesity. The aim of this research was to assess the predictive value of health and lifestyle variables on BMI and body fat distribution (waist circumference WC) whilst controlling for energy intake and physical activity. A representative sample of 1379 subjects (males n=662; females n=717, 18–64 years) participated in the North/South Ireland Food Consumption Survey and completed 7 d semi-quantitative food diaries. Detailed information on each subject's physical activity, health, lifestyle, social class, eating behaviour and attitudes to food and health were collected using self-administered questionnaires. Weight, height and waist circumference were measured by fieldworkers using standard procedures (see www.iuna.net). Univariate regression analysis was used to identify any association between BMI or WC with health and lifestyle variables. If significant associations were found for any variables, these were then included in multiple linear models until the final model was developed. The main predictors of BMI and WC in men and women are presented in the Table.

	BMI men			BMI women			WC men			WC women		
	P	95% CI		P	95% CI		P	95% CI		P	95% CI	
		L	U		L	U		L	U		L	U
Age	***	0.09	0.12	***	0.07	0.10	***	0.28	0.39	***	0.22	0.33
Education level	not included			**	-0.43	-0.11	**	-1.39	-0.30	***	-1.72	-0.62
EI:BMR	***	-23.2	-20.0	***	-34.0	-30.5	***	-60.7	-50.8	***	-67.4	-55.8
Emotional eating	not included			ns	-0.07	0.33	not included			ns	-0.10	1.31
Energy Intake	***	0.01	0.01	***	0.02	0.02	***	0.03	0.03	***	0.04	0.05
Estimated physical activity level	*	0.09	1.10	ns	-0.16	1.09	ns	-1.73	1.44	ns	-0.90	3.64
Geographical location	not included			ns	-0.18	0.07	not included			ns	-0.85	0.07
Height	not included			***	-30.8	-24.6	not included			not included		
Modern conveniences	not included			not included			ns	-2.54	0.24	not included		
My weight is fine for my age	***	0.43	0.80	***	0.32	0.69	***	1.06	2.22	***	1.56	2.82
Region of Ireland	ns	-0.04	0.39	not included			**	0.39	1.70	***	0.59	1.97
Restrained eating	*	0.06	0.56	*	0.02	0.43	ns	-0.34	1.25	ns	-0.23	1.24
Smoking habits	not included			***	0.15	0.55	not included			not included		

Adjusted r^2 >0.65 in the 4 models. Not included indicates that the variable not included in the model for that group. CI = confidence interval, *** = P<0.001, ** = P<0.01,* = P<0.05, ns = non significant

Increasing age positively predicted both BMI and WC in all men and women. Decreasing education level significantly predicted WC in men (P=0.002) and in women (P<0.001). No association was found for education level and BMI in men, while it was a significant predictor of BMI in women (P=0.001). Disagreeing with the statement, 'my weight is fine for my age' was also a significant predictor of BMI and WC in all groups (P<0.001). Many of the variables were found to predict waist circumference or BMI in certain subgroups only. These included restrained eating score, employment status, region of Ireland and smoking habits.

While all of these analyses were controlled for energy intake, energy expenditure and EI:BMR, associations were also found. Increasing energy intake positively predicted both BMI and WC across sex and age groups at P<0.001. Conversely, EI:BMR was inversely associated with BMI and WC for all groups (P<0.001). Physical activity was found to predict BMI in men only (P=0.021).

This work gives an indication of subgroups of the population that require specific, sensitive and targeted public health strategies.

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Moderate and vigorous physical activity may benefit the metabolic syndrome cluster of cardiovascular risk factors. By K.L. RENNIE[1], N. McCARTHY[2], S. YAZDGERDI[2], J.N. MORRIS[3], M. HILLSDON[3], M. MARMOT[2] and E. BRUNNER[2], *[1]MRC Human Nutrition Research, Fulbourn Road, Cambridge CB1 9NL, [2]Department of Epidemiology and Public Health, University College London, 1–19 Torrington Place, London WC1E 6BT and [3]Department of Public Health and Policy, London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT*

Physical inactivity may be important in the aetiology of the metabolic syndrome (MS) cluster of cardiovascular risk factors (Eriksson *et al*. 1997), but the level of intensity of activity to achieve clinical benefit is still being debated (Sesso *et al*. 2000). We examined cross-sectional relationships between moderate and vigorous physical activity and MS in the Whitehall II study of civil servants (age 45–68 years). We also assessed whether the observed association was mediated through cardiovascular fitness and/or body mass index (BMI).

Measures of 2-h glucose, systolic blood pressure, fasting triacylglycerols, waist : hip ratio and high-density-lipoprotein (HDL) cholesterol were obtained in 5153 participants of European origin in the Whitehall II cohort, who had sedentary occupations. Subjects in the most adverse sex-specific quintile for three or more of these risk factors were classified as having MS. Self-reported leisure-time physical activity, including sports, household tasks and time spent walking and cycling, was categorised into moderate (MET ≥3 to <5) or vigorous activity (MET ≥5) expressed in MET hours per week. Each group was further subdivided into four categories, where the top categories met the US Surgeon General's guidelines for activity. Thus the top category for vigorous activity equated to 30 min of activity on 5 days of the week and for moderate activity to 1 h on 6 days. BMI and resting heart rate (HR) were used to estimate degree of fatness and cardiovascular fitness, respectively.

470 men (12.6%) and 200 women (14.0%) were classified with MS. The odds ratio (95% CI) for having MS, after adjustment for age, sex, smoking and high alcohol intake, in the top category of vigorous activity was 0.50 (0.39, 0.64) and for moderate activity 0.78 (0.63, 0.96). This association remained significant for vigorous activity after adjustment for BMI and HR (n=4945). The effect of BMI and HR on the odds ratio of having MS in individuals rated in different activity categories is shown below.

MET h/week	Base	Base + BMI	Base + HR	Base + BMI + HR
Vigorous activity category				
None (n=2722)	1	1	1	1
<5 (n=592)	0.70 (0.52,0.94)	0.88 (0.65,1.21)	0.75 (0.55,1.01)	0.91 (0.67,1.25)
≥5–<12.5 (n=718)	0.77 (0.59,1.00)	0.94 (0.71,1.26)	0.84 (0.65,1.10)	1.01 (0.76,1.34)
≥12.5 (n=913)	0.53 (0.41,0.69)†	0.64 (0.47,0.85)†	0.61 (0.47, 0.80)†	0.69 (0.51,0.92)*
Moderate activity category				
<24 (n=1349)	1	1	1	1
≥24 (n=1373)	0.78 (0.63,0.98)*	0.84 (0.66,1.07)	0.82 (0.65,1.02)	0.88 (0.69,1.12)

P for trend, *P< 0.05, †P<0.01. Only those reporting no vigorous activity included in the moderate activity analysis. Base – analysis adjusted for sex, age, smoking, high alcohol intake and socio-economic status (and moderate activity in vigorous activity models).

Moderate and vigorous leisure-time activity are beneficial to the MS cluster of risk factors among middle-aged populations in sedentary occupations, suggesting that even modest increases in activity may be worthwhile public health targets. However, vigorous activity may afford additional health benefits over and above the associated reduction in body fat and increased cardiovascular fitness.

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Physical activity and energy expenditure during army basic training. By M.P. RAYSON[1], D.A. WILKINSON[1], E. VALK[1] and A.M. NEVILL[2], [1]*BioTel Ltd, Old Chambers, 93–94 West Street, Farnham, Surrey GU9 7EB and* [2]*School of Sport, Performing Arts and Leisure, University of Wolverhampton, Walsall Campus, Gorway Road, Walsall WS1 3BD*

Over the last decade the British Army has made great progress in its policy and practice towards the wider integration of female soldiers. Selection and training are now performed on a 'gender-free' basis (i.e. selection standards are the same for men and women and both genders train to the same syllabus often in mixed gender platoons). While these changes provide equal opportunities to both genders, it has come at a cost of higher injury rates and medical discharges of female recruits (Gemmell, 2002). The objectives of this study were threefold: to quantify the energy expenditure (EE) and physical activity level (PAL) (World Health Organization, 1985) of army recruits undergoing basic training; to compare EE and PAL in recruits of different gender; and to validate the Tracmor accelerometer as a field tool for estimating EE. Six male (mean age 23.5 (SD 3.7), height 1.76 (SD 0.01) m, body mass 73.1 (SD 8.1) kg) and eight female (mean age 19.1 (SD 3.1), height 1.70 (SD 0.04) m, body mass 61.3 (SD 7.4) kg) recruits in a mixed-gender platoon were monitored for two 10 d periods at the start and end of basic training. Body mass (Seca 710; Cranlea, Birmingham), body composition (Bodystat 1500; Bodystat, Isle of Man), and physical activity using Tracmor 3 accelerometers (Philips Research, Eindhoven, The Netherlands) were monitored and Total Energy Expenditure (TEE) was estimated using doubly labelled water (Westerterp & Saris, 1992). Cardiovascular strain was measured using heart rate monitors (Polar Electro Oy, Finland).

The mean TEE was 15.0 MJ/d for male recruits and 12.4 MJ/d for female recruits, male values being on average 20% higher ($P<0.001$). TEE between Periods 1 and 2 were highly correlated ($r = 0.88$, $p<0.001$) and were not different ($P>0.05$), implying that TEE was reasonably constant during basic training. We estimated the recruits to have an energy deficit of approximately 0.5 MJ/d during training. This small energy deficit and the resultant changes in body composition, with an 'exchange' of fat mass for fat-free mass, were interpreted as a positive adaptation to training. PAL (TEE/Basal Metabolic Rate) in recruits averaged 2.0, corresponding to a 'high' activity level, with the highest value being 2.25. These values fell below the proposed threshold of 2.5 for sustainable energy balance (Westerterp, 2001). There were no significant differences in PAL between men and women, suggesting that the stress of basic training is common to both genders, though the resultant cardiovascular strain, reported as percentage of heart rate reserve (%HRR) (Howley, 2001) was found to be different ($P<0.001$). No differences were found between Periods 1 and 2 ($P>0.05$), implying that the relative physical load on recruits is constant throughout basic training.

The Tracmor accelerometer was found to be an accurate and valid tool for estimating TEE during CMS(R). The best prediction equation we could derive to predict TEE was a proportional allometric model incorporating Total Physical Activity Count from the Tracmor, body mass, age and gender, which accounted for 89% of the variance in TEE. Application of the Period 2 data using the Bland & Altman (1986) method indicated no bias in the estimate of TEE and the magnitude of error associated with the prediction models (95% limits of agreement of 12%) was judged to be both very acceptable and the most accurate prediction of TEE reported to date using accelerometers.

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