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Abstracts of Original Communications

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All abstracts are prepared as camera-ready material.

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Postprandial concentrations of retinyl palmitate following ingestion of oil-soluble and water-miscible preparations of retinyl palmitate in healthy adults. By A.L. CAWOOD, J.L. MURPHY and S.A. WOOTTON, *Institute of Human Nutrition, University of Southampton, Southampton SO16 6YD*

Different forms of vitamin A supplement are routinely prescribed to patients at risk of vitamin A deficiency. However, there remains little direct evidence to support the use of one supplement over another and as such a variety of different vitamin A preparations are used in clinical practice. There have been no studies that have compared the postprandial metabolism of fat-soluble preparations and water-miscible preparations of vitamin A given as retinyl palmitate in equivalent doses. There is a need to re-examine the handling of vitamin A preparations in healthy individuals to provide information on the justification for selecting the suitable vitamin A supplements for routine clinical use. The aim of this study was to examine the concentrations of retinol and retinyl esters in the circulation following a single oral dose of retinyl palmitate in oil and a water-miscible preparation in healthy adults on separate occasions against that observed when no vitamin A supplement is given.

Six men (aged 18–33 years) were randomly assigned to the three different trials, conducted at weekly intervals. In each trial, the subjects consumed the same test meal with either (i) a soya bean oil preparation without detectable vitamin A (PLACEBO), (ii) an oil-based preparation of retinyl palmitate (OIL: Vitamin A and D capsules, CP Pharmaceuticals Ltd), (iii) a water-miscible preparation of retinyl palmitate (WM: Vitamin A water miscible, type 100; Roche). The vitamin A preparations were given in equivalent doses of 4.4 mg retinyl palmitate. Venous blood specimens were collected before and at hourly intervals for 6 h following each meal. Retinol and retinyl ester concentrations were analysed by HPLC. The results are shown as mean and SD. The maximum plasma concentration (C_{max}) and time to maximum plasma concentration (T_{max}) and area under the plasma concentration time curve (AUC) over the 6 h postprandial period are shown for plasma retinyl palmitate.

	Pre-dose		C_{max} (nmol/l)		T_{max} (nmol/l)		AU (nmol/l per 6 h)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
PLACEBO	22.8	26.6	41.5	31.1	3.3	1.9	34.8	30.7
OIL	15.5	21.0	166.5*	93.7	2.3	0.5	416.2	196.6
WM	25.2	16.7	366.0***††	98.2	2.3	0.8	1584.0***††	169.9

Mean value significantly different from PLACEBO * $P<0.05$; ** $P<0.01$; *** $P<0.001$;
Mean value significantly different from OIL † $P<0.05$; †† $P<0.001$.

No increase in the plasma concentrations of retinyl palmitate was observed in the PLACEBO trial. The maximum plasma concentration of retinyl palmitate and AUC was more than twice as much for WM than for OIL. There was no difference between the trials in the time to maximum concentrations for retinyl palmitate. These results show that there are differences in the postprandial retinyl palmitate concentrations following equivalent doses when given as oil-soluble or water-miscible preparations that might reflect alterations in absorption across the gastrointestinal tract. Further studies are needed in order to determine whether such differences persist in patients with impaired lipid handling within the gastrointestinal tract, such as cystic fibrosis.

Plasma phospholipid composition and *ex vivo* mononuclear cell TNF-α release in healthy subjects: response to increased *n*-3 polyunsaturated fatty acid and antioxidant intakes. By T. TREBBLE, G.C. BURDGE, E.A. MILES, P. WRIGHT, P.C. CALDER, M.S. STROUD and S.A. WOOTTON, *Institute of Human Nutrition, Southampton General Hospital, Southampton SO16 6YD*

Increased *n*-3 polyunsaturated fatty acid (PUFA) intake is associated with altered plasma phospholipid composition and reduced mononuclear cell response in healthy subjects (Calder *et al.* 1999). Nutritional antioxidants may reduce the pro-inflammatory peroxidation *n*-3 PUFAs, augmenting the effect of *n*-3 PUFA supplementation. Previous trial interventions have varied considerably in terms of *n*-3 PUFA and nutritional antioxidant incorporation. The relationship between *n*-3 PUFA intake and immunological response is poorly defined. We have investigated the effect of (1) increasing *n*-3 PUFA intake and (2) antioxidant co-supplementation, on plasma phosphatidylcholine (PC) composition and peripheral blood mononuclear cell (PBMC) *ex vivo* TNF-α release.

Healthy males aged 26–45 years (*n* 16) received fish-oil supplements consisting of three consecutive 4-week courses of 340 mg, 1025 mg and 2050 mg of *n*-3 PUFA daily. Subjects were randomized to antioxidants (200 μg selenium, 3 mg manganese, 450 μg vitamin A, 30 mg vitamin E, 90 mg vitamin C) or placebo. Fasted venous blood samples were taken at baseline, 4, 8 and 12 weeks. Plasma PC was isolated (Burdge *et al.* 2000) and analysed by capillary gas chromatography. TNF-α production was stimulated in cultured PBMCs by addition of LPS (150 μg/ml). Secretion of TNF-α into the supernatant fraction was measured by ELISA. All subjects completed the 12-week course, with no reported side-effects.

There were no significant difference in plasma phospholipid composition or TNF-α concentrations in culture supernatant fraction between antioxidant and placebo groups (2-way ANOVA) at any intake of *n*-3 PUFA. The results of both groups were pooled for comparison of dose–response effects.

n-3 PUFA supplement		Baseline		342 mg/d		1025 mg/d		2050 mg/d		*P* value
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Plasma PC concentration (μg/ml)	EPA	2.6	0.9	3.9	1.5	7.2*	4.0	9.8*	4.7	<0.0001
	DHA	7.0	2.5	8.3	2.6	11.0*	3.2	12.7*	5.3	0.0003
TNF α unstimulated (pg/ml)		1081	775	658	517	206*	82	276†	179	<0.0001
TNF α stimulated (pg/ml)		2340	1709	1508	670	1121*	618	1309†	730	0.01

P values reflect level of significance across intakes (one-way ANOVA). * indicates significant difference (*P*<0.05) compared to baseline and previous dose, † indicates significant difference (*P*<0.05) compared to baseline only.

Plasma PC eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) concentrations increased with rising intakes of *n*-3 PUFA, but tended towards a plateau response. This difference attained statistical significance at the 1025 mg/d and 2050 mg/d *n*-3 PUFA intakes. TNF-α supernatant fraction concentrations decreased with increasing *n*-3 PUFA up to the 1025 mg/d dose, with no further reduction at the higher intake. This study showed an inverse relationship between plasma phospholipid *n*-3 PUFA concentration, associated with increased *n*-3 PUFA intake, and TNF-α, PBMC release. Antioxidant supplementation did not produce any additional effect.

Burdge GC, Wright P, Jones AE & Wootton SA (2000) *British Journal of Nutrition* **84**, 781–787.
Calder PC (1999) *Lipids* **34**, S137–S140.

Evaluation of the efficacy of ascorbic acid in minimizing lipid peroxidation in lipid emulsions administered to premature babies. By C.A. CONLON[1], A.T. GIBSON[2] and H.J. POWERS[1], [1]Centre for Human Nutrition, Sheffield University; Northern General Hospital, Sheffield S5 7AU and [2]Neonatal Intensive Care Unit, Jessop Wing, Hallamshire Hospital, Sheffield S10 2SF

Premature babies often require parenteral nutrition because of an immature gastrointestinal tract. The administration of the lipid emulsion component has been associated with poor outcome in these babies (Hammerman & Aramburo, 1988). This may be due to the formation of potentially toxic products of lipid peroxidation in the lipid preparations (Helbock et al. 1993). In vitro studies have shown that supplementing the lipid emulsion with 1 mmol/l ascorbate can reduce the formation of lipid peroxides (Neuzil et al. 1995). We hypothesized that antioxidant supplementation of intravenous lipid prior to use would reduce lipid peroxidation in the lipid emulsion and lower the peroxide load in the baby.

A randomized, double blind, placebo-controlled intervention study was conducted to evaluate the efficacy of ascorbic acid in minimizing lipid peroxidation in lipid emulsion administered to premature babies. Forty-eight babies of less than 34 weeks gestation and receiving parenteral nutrition within 48 h of birth were recruited. Babies were randomized to receive lipid supplemented with 1 mmol/l ascorbic acid or lipid to which a placebo had been added. Blood samples were collected daily for 7 d. Lipid emulsion samples were collected at the beginning (pre) and end (post) of each 24 h infusion period, daily for 7 d. Post-infusion samples were also taken from the tubing administering the lipid emulsion to the intravenous catheter. Lipid peroxides were measured in the lipid emulsion and malondialdehyde (MDA), a marker of lipid peroxidation, measured in the plasma.

Lipid peroxide concentrations in pre, post and tube lipid emulsion
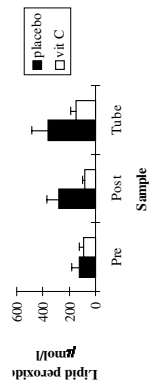
A two-way ANOVA revealed a significant effect of both the treatment and time of lipid sampling on the 7 d average concentration of lipid peroxides in lipid emulsion. An interactive effect was also significant ($P < 0.0001$). The concentration of peroxides in the tubing of the placebo group was significantly higher than the concentration found in the ascorbic acid supplemented group (see Figure). Plasma MDA concentrations were not influenced by treatment.

We conclude that ascorbic acid supplementation of lipid emulsion administered to premature babies reduces the concentration of lipid peroxides in the emulsion but does not influence a measure of plasma lipid peroxidation in the babies.

Hammerman C & Aramburo MJ (1988) Journal of Pediatrics **113**, 1083–1088.
Helbock HJ, Motchnik PA & Ames BN (1993) Paediatrics **91**, 83–87.
Neuzil J, Darlog BA, Inder TE, Sluis K, Winterbourn C & Stocker R (1995) Journal of Pediatrics **126**, 785–790.

Gastrointestinal handling of vitamin A in severely malnourished children at admission and following treatment. By J.L. MURPHY[1], V.A. BADALOO[2], A. CAWOOD[2], B. CHAMBERS[2], T.E. FORRESTER[2], S.A. WOOTTON[1] and A.A. JACKSON[1] [1]Institute of Human Nutrition, University of Southampton SO16 6YD and [2]The Tropical Metabolism Research Unit, University of the West Indies, Jamaica

Severely malnourished children are at high risk of vitamin A deficiency, leading to blindness and ultimately death. During treatment a large oral dose of vitamin A (as retinyl palmitate) may be given routinely in recognition of poor dietary intake and impaired gastrointestinal function. However, little is known about the handling of vitamin A within the gastrointestinal tract and direct measures of the amount and form of vitamin A in stools have rarely been conducted. In this study we examined the excretion of vitamin A as retinol and retinyl palmitate and the extent to which this might be attributed to poor digestion and absorption of dietary lipid.

Twelve children (aged 6–21 months) admitted to the Tropical Metabolism Research Unit (less than 80% weight for age and/or presence of pitting oedema; marasmus, marasmic-kwashiorkor and kwashiorkor) were studied on admission when severely malnourished and afterwards on recovery when weight for height had reached 90% of the reference. All the children were routinely given a single oral dose of vitamin A supplement (Tropovite multivitamin 450 μg retinyl palmitate) immediately on admission. Additional vitamin A was provided by a milk-based formula during treatment increasing from 636 μg/d to 1662 μg/d at recovery with increasing amounts of feed consumed. On each occasion, stools were collected for 3 d. Total stool lipid was analysed by a modification of Folch et al. (1957) and the retinol and retinyl palmitate content of total stool was determined by HPLC. The results are shown in the table (as median and ranges).

	Stool retinol (μg/d)	(% of intake)	Stool retinyl palmitate (μg/d)	(% of intake)	Stool lipid (g/d)	(% of intake)
ADMISSION	4.8 (0–8.7)	0.9 (0–1.5)	36.3[†] (3.6–186.0)	3.4[†] (0.3–18.2)	3.0 (1.5–10.1)	11.4 (4.9–32.7)
RECOVERY	1.1 (0–31.3)	0.1* (0–2.5)	1.6*** (0–30.4)	0.1*** (0–1.2)	2.5 (0.1–6.8)	5.5** (0.3–15.3)

Significantly different from admission values: * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.
[†] Significantly different from retinol: [†] $P < 0.05$, [††] $P < 0.001$ (Mann-Whitney U).

In children who are severely malnourished at admission, relatively more retinyl palmitate than retinol was excreted in stool, although this varied markedly between children. Measured as a proportion of the intake, whilst values for retinol in stool were similar to those reported for normal older children (Ahmed et al. 1990), retinyl palmitate losses in stool were equivalent to nearly 20% of intake. Following treatment, there was a significant reduction in the excretion of retinyl palmitate in stool. There was an association between retinyl palmitate and lipid excreted in stool (r 0.67, $P < 0.001$) but the differences in stool lipid could only account for <50% of the variance in retinyl palmitate losses. There was no association between the lipid and retinol in stool (r 0.31, NS). These results show that there is poor hydrolysis of retinyl palmitate that is related to factors in addition to the maldigestion and malabsorption of dietary lipid. The underlying mechanisms of these increased losses is not clear, but it appears that the lesion does improve with effective treatment during rehabilitation.

Ahmed F, Ellis J, Murphy J, Wootton S & Jackson AA (1990) Archives of Disease in Childhood **65**, 589–593.
Folch J, Lee M & Sloane Stanley GH (1957) Journal of Biological Chemistry **226**, 497–509.

Blood as a biomarker: the antioxidant vitamins. By J.E. POLLARD, D.C. GREENWOOD and J.E. CADE, *Nutrition Epidemiology Group, Nuffield Institute for Health, 71–75 Clarendon Road, Leeds LS2 9PL*

Due to the inherent problems with dietary assessment methodology, there has been a recent move towards using biomarkers of nutrient intake as the 'Gold Standard'. However there is not necessarily a close relationship between the amount of a nutrient found in the diet and values obtained in the laboratory (Margetts & Nelson, 1997). This study aims to investigate the relationship between dietary intake and blood levels of the antioxidant vitamins.

Fifty-nine non-smoking women, from the UK Women's Cohort Study, completed a 4 d food diary with supplement information. The diary data was analysed using COMP–EAT V.5 (Carlson Bengston Consultants) and WISP V.1.27 (Tinuviel Software). Grams of fruit and vegetables (f&v) eaten per day were calculated. All dietary data were averaged over the 4 d period. A fasting blood sample was taken following completion of the diary and antioxidant levels in the plasma were analysed.

Multiple regression modelling investigated the relationship between blood levels of the antioxidant vitamins and dietary intake of these vitamins, from food sources and supplements, and f&v intakes adjusting for age, BMI, presence of chronic disease and mean energy intake.

	Ascorbic acid	β-Carotene	Lutein	Cryptoxanthin	Lycopene
	— Percent increase in plasma micronutrients for a doubling in dietary, supplementary, f&v intakes (95% CI)				
Dietary intake	22.6**a	38.4**b	12.4*b	5.7b	9.2b
	(7.0 to 40.5)	(16.7 to 64.1)	(1.3 to 24.9)	(-10.5 to 24.9)	(-7.3 to 28.6)
Intake from supplements	1.5*a	5.7**b	2.1b	1.0b	-3.5b
	(0.1 to 3.0)	(2.2 to 9.3)	(0.0 to 4.2)	(-2.3 to 4.4)	(-6.6 to -0.3)
Vegetable intake	5.3	22.9*	5.4	-2.1	6.4
	(-8.7 to 21.3)	(1.3 to 49.2)	(-7.7 to 20.4)	(-20.2 to 20.0)	(-12.3 to 29.1)
Fruit intake	1.0	-12.2	-1.5	-1.6	5.2
	(-3.4 to 5.6)	(-16.9 to -7.1)	(-5.1 to 2.4)	(-7.2 to 4.2)	(-0.5 to 11.2)

$**P<0.01$, $*P<0.05$.
a Dietary vitamin C intake and supplemental vitamin C were used in the regression to predict plasma vitamin C.
b Dietary carotenoid equivalents and supplemental β-carotene were used in the regression to predict plasma β-carotene, lutein, cryptoxanthin and lycopene.

No relationships were found between plasma levels of total vitamin A (retinol plus carotenoids) or vitamin E and dietary intake of antioxidant vitamins or f&v estimated from food diaries (data not shown). However a positive relationship was observed between dietary intakes from both food sources and supplements of vitamin C and β-carotene. When vitamin C, from food sources, is doubled this leads to a 23% increase in plasma ascorbic acid ($P<0.01$) and for a doubling in β-carotene, from food sources, a 38% increase in plasma β-carotene is observed. For the carotenoids, other than β-carotene, there was either a poor relationship or no relationship at all between intakes and blood levels. Clear relationships between f&v intakes and plasma levels of the antioxidant vitamins were not seen.

These results show that the relationship between food diary-based estimates of dietary intake and blood levels of the antioxidant vitamins is complex. Perhaps suggesting that the practice of using blood levels of antioxidant vitamins as a biomarker of vitamin intake, or indeed f&v intake, is not valid.

Thanks to Kay White and Chris Wild for blood analysis.

Bengston Consultants Ltd. *COMP–EAT Version 5.* London: Carlson Bengston Consultants Ltd.
Margetts BM & Nelson M (1997) *Design Concepts in Nutrition Epidemiology*, 2nd edn. Oxford: Oxford University Press.
Tinuviel Software. WISP for Windows version 1.27. Nutrient Intake Analysis System. Warrington: Tinuviel Software.

How prevalent is vitamin B12 deficiency among British vegetarians and vegans? By Z. LLOYD-WRIGHT[1], N. ALLEN[2], T.J.A. KEY[2] and T.A.B. SANDERS[1], [1]*Nutrition, Food and Health Research Centre, King's College London, Franklin-Wilkins Building, London, SE1 9NN and* [2]*ICRF Cancer Epidemiology Unit, Gibson Building, Radcliffe Infirmary, Oxford OX2 6HE*

Vitamin B_{12} is unique among the vitamins in that it is synthesized by microorganisms. Plant foods are generally devoid of the vitamin unless contaminated by faecal matter. It has also been argued that small amounts of vitamin B_{12} may be absorbed from vitamin B_{12} synthesized by bacteria in the intestine (Albert *et al.* 1980). Nowadays, many foods acceptable to vegetarians and vegans are fortified with vitamin B_{12}. Vitamin B_{12} deficiency is known to occur among vegans and vegetarians but the prevalence of deficiency is uncertain. In order to ascertain vitamin B_{12} status in British vegans, we first estimated the dietary intake of the vitamin in 250 omnivore, 250 vegetarian and 250 vegan men recruited into the Oxford cohort of the EPIC study from a self-reported food frequency questionnaire. The mean estimated daily intakes of vitamin B_{12} provided by diet in omnivore, vegetarian and vegan men was 9.6, 2.4 and 0.4 μg/d respectively (RNI=1.5 μg/d); when allowance was made for reported supplement use vitamin B_{12} intakes were 9.6, 2.7 and 3.0 μg/d, respectively. We then determined plasma vitamin B_{12} concentrations on 190 omnivore, 188 vegetarian and 191 vegan men. Results are shown as mean values with 95% confidence intervals.
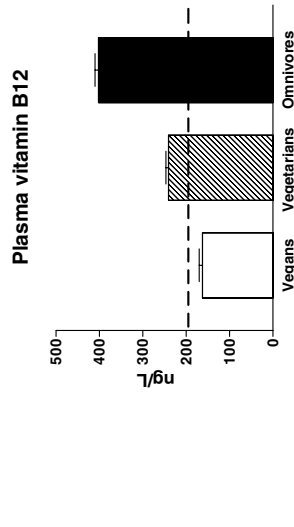
Plasma vitamin B12

Plasma vitamin B_{12} concentrations were significantly different between each of the three groups ($P<0.0001$). 1 omnivore, 50 vegetarian and 150 vegan men had plasma concentrations below 200 ng/l (the lower limit of the normal laboratory range) and 4 vegetarians and 50 vegans had values less than 130 ng/l – the threshold level below which neurological signs of deficiency develop (Herbert, 1994). Elevations of plasma homocysteine concentration are also likely to occur with these low plasma vitamin B_{12} concentrations (Homocysteine Lowering Triallists' Collaboration, 1998). These results suggest that about one-quarter of vegetarian men and more than half of vegan men have suboptimal intakes of vitamin B_{12}. The significance of these findings is uncertain in the absence of clinical signs and symptoms. However, poor vitamin B_{12} status may increase risk of depression (Penninx *et al.* 2000) and other neurological disorders.

Albert MJ, Mathan VI & Baker SJ (1980) *Nature* **283**, 781–782.
Herbert V (1994) *American Journal of Clinical Nutrition* **59**(Suppl), 1213S–1222S.
Homocysteine Lowering Trialists' Collaboration (1998) *British Medical Journal* **316**, 894–898.
Penninx BW, Guralnik JM, Ferrucci L, Fried LP, Allen RH & Stabler SP (2000) *American Journal of Psychiatry* **15**, 715–721.

Combined selenium plus vitamin E deficiency affects differential gene expression: a cDNA array study in rat liver. By G. RIMBACH[1], A. FISCHER[2] and J. PALLAUF[2], [1]*School of Food Biosciences, Hugh Sinclair Human Nutrition Unit, University of Reading, UK,* [2]*Institute of Animal Nutrition and Nutrition Physiology, Justus-Liebig-University, 35392 Giessen, Germany*

In order to obtain a comprehensive understanding of the molecular mechanisms involved in the physiology and pathophysiology of selenium (Se) and vitamin E (VE) a global gene expression profile in the rat liver using a cDNA array was determined (Fischer *et al.* 2001). Four groups of eight male albino rats were fed semi-synthetic diets *ad libitum* over 7 weeks (<0.10 mg α-tocopherol and <30 µg Se/kg diet, group I) based on torula yeast and VE-stripped corn oil containing different supplements of 75 mg DL-α-tocopherylacetate/kg (group II) or 200 µg/kg Se as sodium selenate (group III) or both supplements (group IV). Dietary manipulation of Se and VE affected Se status (liver Se, cGPx, thioredoxin reductase), hepatic α-tocopherol, ascorbic acid and glutathione concentrations as well as lipid peroxidation indicating significant differences in the oxidant/antioxidant balance between the four experimental groups. VE deficiency did not result in any significant changes in differential gene expression in the rat liver. However, out of 465 genes evaluated, twenty-two genes in the combined deficiency and nine genes in the Se deficient group displayed a more than two-fold change in their expression levels compared with controls. Functional classes were assigned to differential expressed genes in the combined VE and Se deficiency. Deficiency was characterized by alterations in the expression level of genes encoding for proteins involved in inflammation and acute phase response. Additionally, a significant down-regulation in the expression level of genes important in the inhibition of apoptosis, cell cycle and antioxidant defense was evident. Some genes are reported for the first time to have changed expression levels in Se- and VE-deficient rats. Advances in microarray technology have allowed us to investigate genes differentially expressed in the rat liver in response to Se and/or VE deficiency thereby offering the possibility of more insight into the biological properties of these micronutrients. cDNA arrays might help to address antioxidants more specifically with regard to their molecular biological functions (Watanabe *et al.* 2001).

Fischer A, Pallauf J, Gohil K, Weber S, Packer L & Rimbach G (2001) *Biochemical and Biophysical Research Communications* **285**, 470–475.

Watanabe CMH, Wolfram S, Ader P, Rimbach G, Packer L, Maguire J, Schultz P & Gohil K (2001) *Proceedings of the National Academy of Sciences, USA* **98**, 6577–6580.

Optimization of a stable isotope method for studying calcium metabolism: pilot study. By J.R. DAINTY, G. MAJSAK-NEWMAN, B. TEUCHER and S.J. FAIRWEATHER-TAIT, *Institute of Food Research (IFR), Colney Lane, Norwich, Norfolk NR4 7UA*

A pilot study was carried out to optimize the double isotope method (oral and intravenous) for the benefit of future human studies related to calcium and bone health. From previous work it was known that samples must be collected for at least 10 d post-dosing to allow an accurate determination of kinetic parameters. The first aim of the study was to validate a computer simulation that was used to predict the minimum isotope doses required to measure the raised isotopic enrichment in volunteers' plasma, urine and faeces 14 d post-dosing. The second aim was to use the enrichment data to construct a compartmental model of short-term calcium metabolism and thereby calculate important kinetic parameters.

Two female volunteers, aged 32 and 58 years, received 14 mg and 9.5 mg, respectively, of enriched ^{48}Ca in an oral dose and 5 mg of enriched ^{43}Ca intravenously. True fractional absorptions were calculated from isotope ratios in serum, urine and faecal samples using a matrix inversion technique. The true fractional absorption calculated from both plasma and urine were in good agreement, whereas the faecal data estimated lower absorptions in both volunteers. A three-compartment model was fitted to the experimental data to determine kinetic parameters. Bone calcium deposition (Vo+) was found to be 0.13 and 0.55 mg/d, bone calcium resorption (Vo–) was –0.08 and 0.28 mg/d and the total exchangeable calcium pool (EP) was 5.3 and 5.5 g, respectively, for the two volunteers.

In conclusion, the isotopic enrichment in the volunteers' samples was still measurable 14 d post-dosing and the derived kinetic parameters from the compartmental model were in agreement with other published results.

Increased exposure to non-haem iron decreases iron absorption by intestinal epithelial cells. By P.A. SHARP[1], S.R. TANDY[2], J.P. TENNANT[1], S. YAMAJI[3], M.R. WILLIAMS[2] and S.K.S. SRAI[3], [1]*Centre for Nutrition and Food Safety, University of Surrey, Guildford GU2 7XH,* [2]*School of Biological Sciences, University of East Anglia, Norwich NR4 7TJ and* [3]*Department of Biochemistry & Molecular Biology, Royal Free and University College Medical School, London NW3 2PF*

Intestinal iron absorption is thought to be mediated by the divalent metal transporter, DMT1 (Fleming *et al.* 1997; Gunshin *et al.* 1997). Recent work from our laboratory has shown that DMT1 is located in the apical membrane of the human intestinal cell line, Caco-2, and is associated with pH-dependent non-haem iron absorption (Tandy *et al.* 2000*a*). The purpose of our current study was to investigate the regulation of DMT1 by dietary non-haem iron. To investigate this problem Caco-2 cells were cultured on Transwell inserts until the cells were fully differentiated (21 d post-seeding). At this time, cells were confluent and fully polarized, forming a distinct brush border (Tandy *et al.* 2000*b*). Cells were incubated for a further 24 h in the presence or absence of 100 μM non-haem iron (provided as ferric ammonium citrate) and iron transport measured using ^{55}Fe followed by scintillation counting. In parallel experiments DMT1 protein levels by western blotting and mRNA levels by RT-PCR were measured. Data from blotting experiments were semi-quantified using Scion Image software. All data are presented as the mean (SEM) of 5–6 separate experiments. Statistical analysis was carried out using one-way ANOVA followed by Scheffe's *post hoc* test or Student's unpaired *t*-test where appropriate.

DMT1 protein levels are regulated by apical iron levels. Caco-2 cells were cultured in the absence or presence of 10–100 μM non-haem iron for the final 24 h of the culture period. Band densities were analysed using Scion Image software. Data groups sharing common letters are not significantly different from each other. Different letters denotes a significant difference (*P*<0.05, one-way ANOVA and Scheffe's *post hoc* analysis)

Exposure of Caco-2 cells to increased non-haem iron decreased pH-dependent iron transport kinetics (V_{max}=0.93 (0.07) nmol/cm² per 15 min⁻¹ control; 0.68 (0.08) nmol/cm² per 15 min⁻¹ iron-loaded; *P*<0.05). The decrease in iron transport function was associated with a reduction in DMT1 protein expression in the apical membrane of Caco-2 cells. Further analysis revealed that changes in DMT1 protein expression were related reciprocally to apical non-haem iron levels (see Figure). Finally, DMT1 mRNA was also decreased by exposure to high iron. Taken together, these data show that iron-dependent regulation of DMT1 functional expression occurs rapidly and at concentrations of iron likely to be found in the intestine following ingestion of a meal. It is possible, therefore, that these mechanisms may be important in optimizing absorption of dietary non-haem iron by enterocytes.

Fleming MD, Trenor CC, Su MA, Foernzler D, Beier DR, Dietrich WF & Andrews NC (1997) *Nature Genetics* **16**, 383–386.
Gunshin H, Mackenzie B, Berger UV, Gunshin Y, Romero MF, Boron WF, Nussberger S, Gollan JL & Hediger MA (1997) *Nature* **388**, 482–487.
Tandy S, Williams M, Leggett A, Lopez-Jimenez M, Dedes M, Ramesh B, Srai SK & Sharp P (2000*a*) *Journal of Biological Chemistry* **275**, 1023–1029.
Tandy S, Williams M, Srai SK & Sharp P (2000*b*) *Journal of Physiology* **527P**, 36P.

Tissue expression, function and regulation of a putative novel zinc transporter, ZnT5. By R.A. CRAGG, S.R. PHILLIPS and D. FORD, *Department of Biological and Nutritional Sciences, University of Newcastle upon Tyne, Newcastle upon Tyne NE1 7RU*

Zinc (Zn) is an essential micronutrient that plays a critical structural role in many proteins and also acts as a catalytic component in over 300 enzymes. Zn is absorbed in the intestine, but the identity of the transport proteins responsible and their regulatory responses to changes in dietary Zn are not fully understood. Understanding of the molecular control of Zn absorption has advanced in recent years, however, and cDNAs of several Zn transporters of the ZnT and ZIP families involved in mammalian Zn transport have been cloned (McMahon & Cousins, 1998; Guerinot, 2000).

ZnT1, cloned in 1995 from a rat kidney cDNA expression library by complementation of Zn-sensitive baby hamster kidney (BHK) cell lines, has widespread tissue distribution in the rat and mouse and is localized on the basolateral membrane of the intestinal enterocyte. ZnT1 is thought to play a role in Zn efflux from cells (Palmiter & Findley, 1995). ZnT2, 26% homologous with ZnT1, has been detected by RT-PCR in the intestine, kidney, seminal vesicles and testis (Palmiter *et al.* 1996*a*). In transfected BHK cells, ZnT2 is localized on acidic intracellular vesicles, where it drives zinc accumulation.

ZnT3 and ZnT4 were cloned through their close homology with ZnT2. Whereas ZnT3 expression is restricted to the brain and testis (Palmiter *et al.* 1996*b*), ZnT4 shows widespread tissue distribution and has been identified in the mammary gland (Huang & Gitschier, 1997).

All four transporters identified have similar characteristics, with six membrane-spanning regions, a histidine-rich intra-cellular loop and a long C-terminal tail.

We have recently identified a further Zn transporter, which we have named ZnT5. Tissue expression and functional data for this transporter have been examined using a variety of techniques and preliminary data are presented here.

Rapid amplification of cDNA ends was used to generate the 5′ portion of a 3′ expressed sequence tag identified through homology to mouse ZnT1. The full-length cDNA includes an open reading frame coding for 520 amino acids sharing 27% identity with mouse ZnT1. Topology analysis predicts twelve trans-membrane domains, a histidine-rich intra-cellular loop, with extra-cellular amino and carboxyl termini.

ZnT5 mediated Zn uptake, determined using 50 μM ^{65}ZnCl₂, was significantly higher in *Xenopus laevis* oocytes injected with ZnT5-cRNA compared with control oocytes (434.9 (137.5) *v.* 39.3 (13.08) pmol/oocyte per 4 h, mean (SEM), *n* 10, *P*<0.001). In addition, zinc efflux from cRNA-injected oocytes was more rapid than from water-injected oocytes (Rate constant at 60–80 min, –0.229 (0.03) *v.* –0.143 (0.03), mean (SEM), *n* 8, *P*<0.05).

ZnT5 mRNA, analysed by RT-PCR, was detected in all mouse tissues and expression levels in the intestine showed a proximal to distal gradient. ZnT5 mRNA levels in human intestinal Caco-2 cells increased when the Zn concentration of the incubation medium was increased gradually from 3 to 100 μM (1.18 (0.14) to 2.29 (0.28), mean (SEM) in arbitrary units, *n* 6, *P*<0.01).

These results demonstrate the ability of ZnT5 to function as a zinc transporter. The effect of zinc on expression levels is consistent with a role in zinc transport and the widespread tissue distribution indicates a general role in zinc homeostasis at the cellular level.

Guerinot ML (2000) *Biochimica et Biophysica Acta* **1465**, 190–198.
Huang L & Gitschier J (1997) *Nature Genetics* **17**, 293–297.
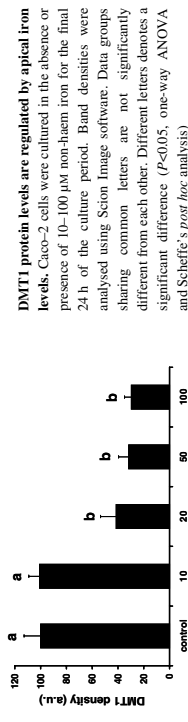McMahon RJ & Cousins RJ (1998) *Journal of Nutrition* **128**, 667–670.
Palmiter RD, Cole TB & Findley SD (1996*a*) *EMBO Journal* **15**, 1784–1791.
Palmiter RD, Cole TB, Quaife CI & Findley SD (1996*b*) *Proceedings of the National Academy of Science* **93**, 14934–14939.
Palmiter RD & Findley SD (1995) *EMBO Journal* **14**, 639–649.

Factors affecting and limiting food choice in a 'food desert'. By D.L. WARM[1], B.M. MARGETTS[1], A.R. WHELAN[2] and N. WRIGLEY[2], [1]*Institute of Human Nutrition and [2]Department of Geography, University of Southampton, Southampton SO16 6YD*

Food consumption patterns on an individual level are determined by a complex interaction of factors, including access (both physical and economic) to and availability of food (Department of Health 1996). This situation may be exacerbated in neighbourhoods that have little or no provision of food, areas known as 'food deserts' (Donkin *et al.* 1999).

The baseline results presented are part of an interdisciplinary cohort study investigating food shopping and consumption patterns within a known 'food desert' located in a socio-economically deprived area of Leeds, England. The type of housing, age of residents, and economic status of the study area was not homogeneous and therefore the sample reflected this diversity (*n* 1009). The person in each household principally responsible for domestic arrangements completed a self-administered 7 d food diary and an interviewer-administered questionnaire that included questions on factors affecting and limiting choice of food.

The national average for fruit and vegetable consumption is approximately three portions per person per day (Gregory *et al.* 1990). In order to see if there were any group differences, the sample was divided into those who consumed more than the national average (*n* 361, 35.8%) and those who consumed less (*n* 648, 64.2%). Mean fruit and vegetable (f&v) intake was 2.77 portions per person per day Fruit and vegetable consumption has been calculated as a proxy measure for the intake of a healthy diet.

Factors affecting or limiting the choice of foods bought	Overall percentage of respondents	Lower than national average f&v consumers (%)	Higher than national average f&v consumers (%)
The costs of food/my food budget	73.3	73.3	73.4
The kinds of food I like eating	62.5	62.7	62.3
What is available in the store that I can get to	51.5	51.1	52.4
Trying to eat a healthy diet	51.3	40.1	71.5***
What my spouse/partner will eat	44.8	46.0	42.7
What my child/children will eat	40.7	47.5	28.5***
Convenience	33.1	36.1	27.7***
Food goes off before its eaten	29.5	33.2	23.0***
Ability to carry and transport foods home	28.1	26.7	30.7
Advice from health professionals	18.2	11.6	30.2***

χ^2 statistical test: Statistical difference between consumption groups ***$P<0.001$, **$P<0.01$.

Nearly three-quarters of all respondents mentioned cost as the main factor limiting their choice of foods, although the proportion mentioning cost was not different between the two groups as defined by their f&v intake in relation to the national average. Higher f&v consumers were more likely to cite 'trying to eat a healthy diet' and 'advice from health professionals' but were less likely to refer to 'what my child/children will eat', 'convenience' and 'food goes off before its eaten'.

Whilst cost, habits (eating foods that I like) and availability of foods are important in influencing consumption, they do not differ between high and lower consumers of f&v, although attitudinal differences do exist and this may be important to take into account when developing programmes to improve access in 'food deserts'.

Department of Health (1996) *Low Income, Food, Nutrition and Health: Strategies for Improvement.* London: HMSO.
Donkin AJM, Dowler EA, Stevenson SJ & Turner SA (1999) *British Food Journal* **101**, 554–564.
Gregory J, Foster K, Tyler H, Wiseman M (1990) *The Dietary and Nutritional Survey of British Adults.* London: HMSO.

Dietary changes in free-living adults after changing to a vegetarian diet. By R.L. REID and A.F. HACKETT, *Liverpool John Moores University, I.M Marsh Campus, Barkhill Road, Aigburth, Liverpool L17 6BD*

Studies of vegetarians suggest that vegetarian diets have positive effects on many chronic diseases and their risk factors. Vegetarians do not differ from meat eaters simply in terms of meat consumption, but also in many other important dietary factors.

A sample of thirty-seven omnivorous volunteers was recruited and asked to follow a self-selected vegetarian diet for 12 weeks. A series of 3 d dietary diaries were completed and analysed using Microdiet (University of Salford). Summary measures (Matthews *et al.* 1990) were used to investigate differences in intake of selected nutrients between baseline and after changing to a vegetarian diet and between the vegetarian period and follow-up.

Nutrient	Baseline (n 37) Mean (SE)	Summary (n 37) Mean (SE)	Follow-up (n 37) Mean (SE)	Baseline – Summary 95% CI	P value	Summary – Follow-up 95% CI	P value
Energy (MJ)	9.19 (0.39)	9.23 (0.40)	8.76 (0.40)	-0.66 – 0.59	0.91	-1.04 – 0.10	0.10
Fat (g)	83.2 (4.81)	83.5 (4.11)	75.5 (4.56)	-8.41 – 8.62	0.98	-15.27 – -0.75	0.03†
SFA (g)	27.8 (1.60)	28.2 (1.35)	26.0 (1.61)	-3.40 – 2.78	0.84	-6.49 – 2.17	0.32
MUFA (g)	25.0 (1.62)	24.9 (1.29)	22.4 (1.49)	-2.76 – 3.03	0.92	-4.82 – -0.23	0.03*
PUFA (g)	15.6 (1.26)	17.0 (1.13)	13.8 (1.29)	-3.83 – 1.05	0.25	-5.32 – -1.22	0.00†
P:S	0.58 (0.04)	0.63 (0.03)	0.72 (0.16)	-0.14 – 0.04	0.30	-0.23 – 0.40	0.57
Protein (g)	85.3 (3.83)	70.3 (2.67)	75.4 (3.00)	7.97 – 22.11	0.00†	-0.33 – 10.59	0.06
NSP (g)	15.7 (0.92)	17.0 (1.01)	15.6 (0.99)	-2.96 – -0.46	0.14	-2.93 – 0.22	0.09
Iron (mg)	14.7 (0.81)	13.7 (0.72)	13.1 (0.83)	-0.42 – 2.36	0.16	-1.60 – 0.31	0.18
Zinc (mg)	9.6 (0.47)	7.8 (0.40)	8.9 (0.50)	0.90 – 2.76	0.00†	0.27 – 1.83	0.00†
Vitamin C (mg)	103.8 (9.45)	94.9 (6.46)	92.8 (9.93)	-11.49 – 29.22	0.38	-20.82 – 16.51	0.81
Vitamin B (µg)	4.6 (0.45)	3.8 (0.28)	3.7 (0.32)	-0.30 – 1.92	0.14	-0.78 – 0.71	0.92

* $P<0.05$, † $P<0.005$.

Of the selected nutrients, protein and zinc were the only nutrients to show a significant difference in intake between baseline and the vegetarian period, both showed a decrease (P 0.000). Zinc also showed a corresponding increase between the vegetarian period and follow up ($P=0.009$). Significant reductions in the intake of total (P 0.03), monounsaturated (P 0.03) and polyunsaturated (P 0.003) fat were observed between the vegetarian diet and follow up, there was no significant effect on the P:S ratio over the same time period. Whilst various studies have investigated the effects of 'traditional' vegetarian diets, Nathan (1995) and Robinson (1998) suggest a new era of vegetarianism, which is no guarantee of a healthy diet. The absence of significant dietary differences upon changing to a vegetarian diet supports the suggestion of a new era of vegetarianism.

Matthews JNS, Altman DG, Campbell MJ, Royston P (1990) *British Medical Journal* **300**, 230–235.
Nathan I (1995) The dietary intake and growth of vegetarian children (aged 7–11) compared with matched omnivores in NW England. PhD Thesis, LJMU, Liverpool.
Robinson (1998) Changing to a self selected vegetarian diet: two studies of diet and selected physical and lifestyle parameters. PhD Thesis, LJMU, Liverpool.

How do women achieve a low fat diet? By C. GOLDING[1], J. CADE[1], C. LAWTON[2] and D. GREENWOOD[1], [1]*Nutrition Epidemiology Group, Nuffield Institute for Health, Leeds LS2 9PL and* [2]*School of Psychology, University of Leeds, Leeds LS2 9JT*

Recommendations to reduce fat intake have been a key target of nutrition policy in the UK since the 1980s (Department of Health, 1992). Little is known about how to *successfully* reduce fat in the diet and it is therefore important to increase our understanding of how to achieve dietary goals in the free-living population.

Participants of the UK Women's Cohort Study (aged 35–69 years) who had effectively completed a 217-item Food Frequency Questionnaire (FFQ) and, to date, been mailed a 4 d food diary (n 11, 935) were included in this analysis. Low-fat (LF) and high-fat (HF) consumers were identified by splitting the group into tertiles. LF consumers ate <68 g fat/d (n 3978) and HF consumers ate >94 g fat/d (n 3978). Exploration of foods contributing to fat and energy intakes looked likely to identify possible substitution or omission of individual foods between the groups. The percentage contribution of the top ten foods to energy and fat intakes for the LF and HF groups is presented in the table.

Percentage contribution of food to energy				Percentage contribution of food to fat			
LF	(%)	HF	(%)	LF	(%)	HF	(%)
Wholemeal bread	5.0	Wholemeal bread	4.4	Cheddar type cheese	4.0	Butter	5.1
Half-fat milk	3.4	Half-fat milk	2.9	Half-fat milk	3.8	Polyunsaturated marg.	5.0
Jacket potato	3.1	Boil/mash potatoes	2.4	Polyunsaturated marg.	3.3	Cheddar type cheese	4.7
Bananas	3.0	Cheddar type cheese	2.4	Tomatoes	2.3	Mini chocolate bars	2.9
Wine	2.7	Mini chocolate bars	2.2	Butter	2.3	Fromage frais	2.7
Boil/mash potatoes	2.6	Muesli	2.0	Wholemeal bread	2.1	Half-fat milk	2.6
Apples	2.5	Jacket potato	2.0	Omelette/scrambled egg	2.0	Pistachios/peanuts	2.5
Fat-free milk	2.3	White bread	2.0	Fromage frais	2.0	Mayonnaise/salad cream	2.2
Muesli	2.0	Butter	1.9	Boiled/mashed potatoes	2.0	Whole milk	1.8
Brown bread	2.0	Bananas	1.9	Mushrooms	1.9	Omelette/scrambled egg	1.8

Six out of the top ten food items contributing to energy were the same for the two fat groupings and, of these, five contributed a higher percentage to energy in the LF group than the HF consumers. Wine, apples, fat-free milk and brown bread only featured in the LF consumers top ten for energy whereas cheese, mini chocolate bars, white bread and butter were only in the HF group.

For fat, again six out of the top ten contributors were the same for the LF and HF groups. Of these six foods, the HF group had a higher percentage contribution from butter, polyunsaturated (PUFA) margarine, cheese and fromage frais than the LF group. Tomatoes, wholemeal bread, boiled/mashed potatoes and mushrooms were only in the top ten fat contributors for the LF group, and mini chocolate bars, pistachios/peanuts, mayonnaise/salad cream and whole milk were only in the HF group top ten.

Milk is a principal source of energy and fat in both LF and HF consumers. However, the LF group chose lower fat alternatives of milk more frequently than the HF group. The percentage contribution to fat of PUFA margarine and butter was 5.6% in LF consumers compared with 10.1% in the HF group. The HF group ate foods high in fat more frequently, for example nuts and chocolate, whilst the LF group chose fruit more often. HF consumers chose mini chocolate bars in preference to larger bars.

Successful LF consumers appeared to be substituting high fat foods with reduced fat alternatives and reducing frequency of consumption of foods high in fat. The findings of this study have important implications for future food policy in relation to encouraging HF consumers to adopt lower-fat diets.

Department of Health (1992) *The Health of the Nation: A Strategy for Health in England.* London: HMSO.

Geographical and demographic factors affecting food access in Barnsley. By T. PEARSON and M.E. BARKER, *Centre for Human Nutrition, The University of Sheffield, Coleridge House, Northern General Hospital, Herries Road, Sheffield S5 7AU*

Food access and availability is thought to be a factor in poor diet within certain areas of the UK (Donkin *et al.* 1999, 2000). This study was undertaken to explore food access in the borough of Barnsley, which has high rates of morbidity and mortality from diet-related disease and lies within the South Yorkshire Coalfields Health Action Zone. An objective of this study was to compare food access in urban electoral wards with that in rural areas.

A randomized postal survey of 1000 households from four electoral wards (Monk Bretton, Cudworth, Penistone East and Penistone West) was used to collect data on food shopping habits. Questions relating to shop type, shop location, transport, mobility and eating habits were used to assess food access within the chosen urban and rural wards. The data were analysed using SPSS, statistical testing was by χ^2 tests.

Response rates varied from 49% to 62% according to electoral ward, and averaged 54%. The sample consisted of 60% employed, 27% retired, 11% long-term sick/unemployed. The mean age of the sample was 52.5 (SD 14.1) years and ranged from 18 to 99 years. Over 85% of the sample had lived in the Barnsley area for more than 10 years.

The postal survey data showed that satisfaction with local shops varied significantly between wards ($P<0.05$), with a general decline being observed west of central Barnsley into the rural Penistone areas. Over 85% of Penistone West respondents commented that their local shops were inadequate, at the same time the highest usage of local shops, 76%, was reported by the same residents. This low satisfaction but high usage may indicate a dependency on inadequate shops for some residents. There were significant differences in local shop usage between the four study wards ($P<0.01$).

The data also suggest that manual households and older adults (≥65 years) have more difficulty accessing food. Comparison of manual and non-manual occupations showed that manual workers were less likely to be car owners ($P<0.05$). They were also more likely to use buses ($P<0.01$) and rely on lifts from other car owners ($P<0.01$) in order to do their food shopping. Manual households were likely to have less autonomy in choice of food shops. There was a significant reduction in car ownership among the older adults group ($P<0.001$). This group was more likely to rely on ($P<0.001$) and walk to ($P<0.001$) local shops, whilst at the same time they were more likely to report having difficulties with walking and getting about ($P<0.001$).

These findings suggest that there was likely to be a sizeable rural population who rely on local services, be they local shops or a transport network to access shops outside their immediate neighbourhood. When set against an aging population demographic and a general decline in local services, food access may be an important factor as a determinant of diet in a rural area.

Donkin AJM, Dowler EA, Stevenson SJ & Turner SA (1999) *The British Food Journal* **101**, 554–564.
Donkin AJM, Dowler EA, Stevenson SJ & Turner SA (2000) *Public Health Nutrition* **3**, 31–38.

Self-esteem and body weight status in women. By J.J. LARA and M.E.J. LEAN, *Department of Human Nutrition, University of Glasgow, Glasgow Royal Infirmary, Glasgow G31 2ER*

It is widely accepted that physical appearance is an important component of self-esteem. However, whether obese individuals have lower self-esteem than their non-obese counterparts is still a matter of debate. This study assessed the relationship between body mass index (BMI) and self-esteem in a group of female nurses.

Self-esteem was assessed using Rosenberg's scale (1965) in 131 female nurses whose BMI ranged from 19 to 55 (mean BMI 27.0±5.5). Marital status and level of satisfaction with body weight (assessed using the Likert scale) were recorded. The Likert scale ranks responses from very satisfied to very dissatisfied and Rosenberg's scale ranks responses from 10 (highest self-esteem) to 40 (lowest self-esteem).

| | Self-esteem score | | | | | | | | |
| | BMI<25 (n 52) | | | BMI 25–30 (n 45) | | | BMI>30 (n 37) | | |
	Mean	SD	n	Mean	SD	n	Mean	SD	n
Age category									
Age <40 years	23.5	1.6	44	23.8	2.0	25	23.4	2.0	21
Age >40 years	23.4	1.4	8	24.8	1.5	20	24.1	2.2	15
Marital status									
Single	23.3	1.1	28	23.5	1.6	20	22.9	2.1	12
Married	23.8	2.0	21	25.0	1.8	22	23.9	2.1	19
Divorced	24.0	1.4	2	25.0	–	1	24.7	1.1	3
Widowed	–	–	0	22.0	0.0	2	27.0	–	1
Body weight satisfaction									
Strongly satisfied	24.0	1.4	2	–	–	0	–	–	0
Satisfied	22.9	1.3	18	23.4	1.5	7	23.0	–	1
Neither satisfied nor dissatisfied	23.4	1.1	13	22.3	2.2	4	22.0	1.4	4
Dissatisfied	24.0	2.0	17	24.4	1.4	24	23.2	1.9	19
Strongly dissatisfied	24.0	1.5	2	25.1	2.4	10	25.2	1.9	13

No significant relationship between BMI and self-esteem was observed. Mean self-esteem score was significantly higher in subjects (of all BMI) >40 years group compared with those <40 years (P 0.02). Similarly, mean self-esteem score (in all BMI categories) was significantly higher in subjects who were married (indicating lower self-esteem) compared with subjects of other marital status (P 0.01). When questioned about the level of satisfaction with their body weight, those declaring dissatisfaction had the lowest self-esteem. Indeed twenty-one out of twenty-four subjects with responses in the lowest self-esteem tertile declared dissatisfaction with their body weight. Fifteen of those subjects dissatisfied with their body weight were married, four were single, one was divorced and one was widowed.

Our results in female nurses showed that age was significantly correlated (r 0.26, P 0.02) to self-esteem score and that subjects who were married had lower self-esteem (ANOVA, P 0.01), while BMI showed no correlation (r 0.11, P 0.20). Supporting this finding, we found a higher prevalence of dissatisfaction with body weight among those married who reported lower self-esteem at any level of BMI. It is likely that other factors not investigated in this study were also influential, which justifies more work on the interrelationships of psychological, but also sociological, factors such as interpersonal relationships and body weight.

Rosenberg M (1965) *Society and the Adolescent Self-Image.* Princeton, NJ: Princeton University Press.

Effectiveness of dietary intervention strategies aimed at increasing consumption of whole grain or low- and reduced-fat food products in free-living volunteers. By A. SMITH[1], S. KUZNESOF[2], D.P. RICHARDSON[3] and C.J. SEAL[1], [1]*Human Nutrition Research Centre, Dept. of Biological and Nutritional Sciences,* [2]*Dept. of Agricultural Economics and Food Marketing, University of Newcastle, Newcastle upon Tyne NE1 7RU and* [3]*Nestlé UK Ltd, St George's House, Croydon CR9 1NR*

Dietary factors such as the intake of total and saturated fat are involved in the aetiology of several chronic diseases. Despite reductions in intakes over the past decade, fat consumption still exceeds Department of Health recommendations in the population. Substitution of standard foods with low- or reduced-fat products is one strategy that is useful in reducing the percentage of energy derived from fat, without affecting energy balance (Gatenby *et al.* 1997). However, there is a varied response in acceptability of such products and barriers exist to their long-term use (Lloyd *et al.* 1995). Consumption of foods rich in whole grains is associated with decreased risk of several non-communicable diseases such as heart disease, Type 2 diabetes and some cancers (Richardson, 2000). Despite attempts to raise awareness and increase whole grain consumption, current intakes in the US population remain below recommended amounts (Krauss *et al.* 1996), with no comparable data for the UK. Encouraging increased carbohydrate consumption in the form of whole grains is a positive health message compared with the negative health messages associated with reducing fat intake.

Twenty healthy males (n 10, 22–53 years) and females (n 10, 24–50 years) completed a baseline 7 d food diary and were randomly allocated to one of two groups; 'low-fat' (LF) or 'whole grain' (WG). The LF group were provided with a selection of low- and reduced-fat products for incorporation into their diet for 2 weeks, reinforced with negative healthy eating messages based upon the need to reduce fat intake. The WG group received a selection of whole grain foods for incorporation into their diet for 2 weeks, reinforced with positive healthy eating messages based upon the merits of increasing whole grain consumption. Each volunteer completed a second 7 d food diary in the second week of the intervention. Volunteers were also asked to complete short ratings of satisfaction with the diet on 6 of the 14 intervention days. Approximately 1 month following the intervention, volunteers attended a focus group discussion session to explore attitudes towards the diets and post-intervention food purchasing patterns.

| | Low fat | | | Whole grain | | |
	Females	Males	SEM[a]	Females	Males	SEM[a]
Baseline energy intake (kJ/d)	9018	10391	364.9	8929	10209	676.2
Change in intake (Intervention − Baseline)						
Total energy (kJ/d)	−1467**	−491	743.4	665.5	49.1	324.6
% daily energy from:						
Carbohydrate	4.7*	5.3†	1.3	5.5	5.9*	1.5
Fat	−7.2*	−9.8**	1.2	−4.9‡	−5.7§	1.4
Protein	1.8	3.7*	0.9	0.5	0.5	0.6
Alcohol	0.6	0.6	1.1	1.0	−1.0	1.1

[a]Pooled standard error. *Significantly different from zero; *P<0.05; **P<0.01, ***P<0.001, †P 0.064, ‡P 0.088, §P 0.052.

There was no difference in baseline energy intakes between the two groups. The LF group and females from the WG group showed a reduction in energy intake between baseline and intervention, which was significant for LF females. Males and females from both groups achieved a decrease in percentage energy derived from fat, which was significant for the LF group. This was balanced by an increase in energy from carbohydrate and protein. Most volunteers reported general satisfaction with both interventions and had adopted some products as part of their diet post-intervention.

The results suggest that both intervention strategies could be effective in reducing the proportion of dietary energy from fat. The reduction in energy intake, observed most markedly in the LF females, may have implications for normal-weight individuals who need to reduce the proportion of fat in their diet without affecting energy balance.

Gatenby SJ, Aaron JJ, Jack VA & Mela DJ (1997) *American Journal of Clinical Nutrition* **65**, 1867–1873.
Krauss RM, Deckelbaum RJ, Ernst N, *et al.* (1996) *Circulation* **94**, 1795–1800.
Lloyd HM, Paisley CM & Mela DJ (1995) *Journal of the American Dietetic Association* **95**, 316–322.
Richardson DP (2000) *Nutrition Bulletin* **25**, 353–360.

Differences in perceptions of functional foods: the public versus nutritionists. By A. McCONNON[1], P.L. FLETCHER[2], J.E. CADE[1], D.C. GREENWOOD[1] and A.D. PEARMAN[3], [1]Nutrition Epidemiology Group, Nuffield Institute for Health, 71–75 Clarendon Road, Leeds LS2 9PL, [2]Leeds Metropolitan University, City Campus, Leeds LS1 3HE and [3]Leeds University Business School, Maurice Keyworth Building, The University of Leeds LS2 9JT

At a time when concepts in nutrition are moving towards emphasizing the use of foods to promote better health and to help reduce the risk of disease (Roberfroid, 2000), a new generation of functional food products has emerged. Nutritionists play a key role in educating the public on matters regarding diet and health, therefore they need to understand consumers' attitudes to ensure that their work is effective. This study aims to explore consumers' and nutritionists' perceptions towards this relatively new concept in nutrition.

A psychometric questionnaire, adapted from Fife-Schaw & Rowe (1996), quantified attitudes towards five types of functional foods. The questionnaire was administered to 331 members of the public (response rate 40%) and a random sample of 199 members of the Nutrition Society (58% response rate). Perceptions held by the two groups were compared. Principal Components Analysis was carried out to highlight underlying components revealed by the questionnaire.

	Plant sterols		Folic acid		Probiotics		Reduced salt	
	P	N	P	N	P	N	P	N
Awareness of consumption	2.5	3.5	2.6	3.8	2.6	3.8	3.2	3.7
1= never can tell, 5= always can tell								
Responsibility to inform	4.0	3.4	3.8	3.3	3.9	3.4	3.7	3.3
1= totally mine, 5= totally manufacturers								
Understanding	1.9	2.8	2.4	3.4	2.1	2.9	2.8	3.2
1= nothing, 5= everything								

* The difference in the scores between the groups was statistically significant for all comparisons presented (*P*<0.001, Mann-Whitney) (P = public, N = nutritionists).

The scores presented (see table) show the most extreme differences in perceptions on three issues: the ability to tell whether functional foods were about to be consumed; who should take responsibility for informing consumers about the health effects, and understanding of functional foods. Nutritionists believed they had a greater understanding of functional foods and found it easier to tell if the foods they ate contained a functional component. Consumers had a stronger belief that it is the food manufacturers' responsibility to provide information about functional foods. Using Principal Components Analysis to identify components of importance confirmed differences in perceptions. For nutritionists, the consumer group, worry and benefit were the most prominent components. For nutritionists, components relating to control and responsibility were most apparent.

As consumers are more willing to look to food manufacturers than the Government for information regarding these new foods, the importance of appropriate food labelling and legislation on health claims is of increasing importance. The differences in perceptions will be of interest to the different stakeholders involved in the provision of information to consumers, and should be used to ensure appropriate messages and channels of communication are used in the development of this new branch of nutritional science.

Fife-Schaw C & Rowe G (1996) *Risk Analysis* **16**, 487–500.
Roberfroid MB (2000) *American Journal of Clinical Nutrition* **71**, 1660S–1664S.

Public perception of possible health effects associated with functional foods. By A. McCONNON[1], J.E. CADE[1], D.C. GREENWOOD[1] and A.D. PEARMAN[3], [1]Nutrition Epidemiology Group, Nuffield Institute for Health, 71–75 Clarendon Road, Leeds LS2 9PL and [2]Leeds University Business School, Maurice Keyworth Building, The University of Leeds LS2 9JT

Technical advances in the food industry, increased life expectancy and extensive media coverage of health care issues have led to greater consumer interest in the potential health benefits of newly emerging food concepts, such as functional foods (Hardy, 2000). Functional foods can be described as food products delivering health benefits beyond adequate nutritional effects, thus either improving the state of health and well-being and/or reducing the risk of disease (Diplock et al. 1999). The aim of this study was to obtain opinions on a range of different categories of functional foods.

A psychometric questionnaire, adapted from Fife-Schaw & Rowe (1996), was administered to 331 subjects, with a response rate of 40% achieved. The mean age of respondents was 54 years, 70% of respondents were female, over half (54%) were married and a third described themselves as retired.

Principal Components Analysis was applied, investigating the relationship between the different functional foods. From this analysis four main components were identified (see table). Subjects who felt they understood more about functional foods felt that it was the manufacturers' responsibility rather than the government's to keep them informed about the possible health effects of these foods. However, those who understood less felt it was more the government's responsibility.

	Worry*	Benefit*	Control*	Responsibility*
Foods containing plant sterols	0.22 (1.1)	-0.55 (0.9)	-0.41 (1.0)	-0.29 (1.0)
Foods containing added folic acid	-0.5 (1.0)	-0.03 (0.9)	-0.21 (0.9)	-0.04 (1.0)
Foods containing probiotics	0.4 (1.2)	-0.5 (1.0)	-0.2 (1.0)	-0.2 (1.0)
Foods with reduced salt	-0.25 (0.8)	0.2 (0.8)	0.2 (0.8)	0.2 (0.9)
Foods with naturally occurring health benefits	-0.35 (0.8)	0.9 (0.8)	0.7 (0.9)	0.3 (1.0)

Mean scores (SD) for the five functional foods, based on the four principal components identified from the functional food perception questionnaire. *Difference in mean scores between the five food types was statistically significant (*P*<0.001) for each of the components. Scores were standardized to have overall mean 0, SD=1.

Foods with naturally occurring health benefits, such as oily fish and garlic, were perceived as having the greatest benefits to health, with subjects feeling less worried about them and believing that they have most responsibility and control over consuming them. Foods containing probiotics and foods containing plant sterols were perceived in a more negative light. Subjects claimed to understand least and were more worried about them, and believed they provided least benefit (see table). This could indicate that consumers are more concerned about synthetic products, and this could act as a deterrent for consumption.

These findings should be of interest to the key stakeholders involved in the development of functional foods. Communication of the proposed health benefits of functional foods to consumers by the food industry, government and health professionals is important in the development of functional food research (Diplock et al. 1999). Therefore awareness of consumer perceptions of this emerging food concept are essential to key stakeholders for successful future development in this area.

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Fife-Schaw C & Rowe G (1996) *Risk Analysis* **16**, 487–500.
Hardy G (2000) *Nutrition* **16**, 688–697.

The effect of an after-school 'Food Club' on food preparation skills and nutritional knowledge.
By P.J. MOYNIHAN[1], A.S. ANDERSON[2], R. STACY[1], R. HYLAND[1], S.A. REVILL[1], J. HOOPER[1], A. MATHER[1] and A.J. ADAMSON[1], [1]Human Nutrition Research Centre, University of Newcastle, Newcastle upon Tyne NE1 4LP and [2]Centre for Public Health Nutrition Research, Department of Epidemiology and Public Health, University of Dundee, Dundee DD1 4HT

The inability or lack of confidence to prepare healthy inexpensive foods may be a barrier to achieving a healthy diet (National Food Alliance, 1997). As part of a controlled nutrition intervention (after-school Food Club), nutrition knowledge and food preparation skills were assessed by questionnaire in 198 children (100 test, 98 control) aged 11–13 years, at baseline and following two terms of a weekly after-school food preparation club. Nutrition knowledge was assessed by asking the children to select the healthiest choice from a list of options and for each correct answer they received 1 point (maximum score 8). Ingredients knowledge was assessed by asking the children to list the main ingredients in four dishes (maximum score 15). Subjects were asked the cooking times for five foods (maximum score 5). Cooking confidence was assessed by asking the children if they could make nine specified dishes all by themselves (3 points), with a little help (2 points), with a lot of help (1 point), or not at all (0 points). Points were summed to give a cooking confidence score (maximum score 27). In order to further explore the affect of the food club on food preparation skills and confidence, qualitative semi-structured interviews were conducted in a 20% sub-sample of the test group and their parents, selected to represent all schools in the test group, both sexes and a range of attendance patterns. Questionnaire data were entered into SPSS, median scores (interquartile range (IQ range)) were derived and differences within and between groups determined using the Wilcoxon test and Mann-Whitney test, respectively. Qualitative data were transcribed and analysed into themes using QSR*NUDIST software. Of the 198 children, 161 (79 test and 82 control) completed the assessment.

	Nutrition knowledge		Ingredients score		Cooking times score		Cooking confidence	
	Median	IQ range	Median	IQ range	Median	IQ range	Median	IQ range
Test								
T0	6	4–7	11	9.5–13	3	3–4	19	15–23
T1	6	5–7	13	9–13	3	3–4	22	18–24
T1–T0	0	–1–1	1	–4–4	0	–1–1	2	–1–6
P*	0.32		0.001		0.39		0.001	
Control								
T0	5	4–6	7	5–9	3	2–5	17	13–20
T1	6	5–7	9	7–12	3	3–4	20	16–22
T1–T0	0	0–2	2	0–4	0	–1–1	2	–1–6
P*	0.04		0.001		0.32		0.001	

P* Wilcoxon test for within group changes.

The questionnaire data showed no significant differences between groups for changes in any of the scores. Cooking confidence and knowledge of ingredients increased in both groups and therefore cannot be attributed to attendance at the food club. However, qualitative analysis indicated that the Food Club did have a positive effect on cooking skills and confidence. Children recalled having learned the following: how to chop vegetables, how to use a cooker, how to use a sharp knife, how to follow a recipe. They reported greater confidence in their cooking ability and parents reported increased cooking confidence in their children. It is argued that although the 20-week Food Club intervention did not produce statistically significant changes in the quantitative measures, the qualitative data show that children and parents did perceive increased skills and relative confidence in some aspects of cooking and suggest that Food Clubs can have beneficial effects on skills and confidence.

National Food Alliance (1997) Myths about Food and Low Income. London: National Food Alliance.

Individuals' perception of diet with regard to health compared with recorded intake. By U.R. TOHILL, P.J. CURTIS, A.J. ADAMSON and J.C. MATHERS, Human Nutrition Research Centre, University of Newcastle, Wellcome Laboratories, Royal Victoria Infirmary, Queen Victoria Road, Newcastle upon Tyne NE1 4LP

It has been shown that individuals over-estimate how healthy they actually are (Margetts et al. 1997); this may be partly due to 'unrealistic optimism'. Hoorens (1994) describes this as when individuals understand and accept health-promoting messages but fully believe that they are more appropriate for others, perhaps since they believe their own behaviour already conforms.

The aim of this analysis was to measure whether individuals were able to assess accurately their own diet as 'healthy' or 'unhealthy'. The Newcastle Family, Food and Health Project (Adamson et al. 2000) assessed individuals' diet using a 3 d diary followed by interview, using food photographs to quantify portion sizes (MAFF, 1997) prior to entry into an intervention study. A self-completion questionnaire asked subjects to assess their own diet by responding to the question 'How healthy do you think the way you usually eat is?' on a 5-point scale ranging from very unhealthy through neither unhealthy nor healthy to very healthy; and to agree or disagree with the statement 'I know which foods are healthy'. Dietary intake and completed questionnaires were collected from 367 adults aged 16–61 years. Completed data for this analysis (dietary intake and relevant sections of the questionnaire) were collected from 302 adults (120 men and 182 women).

28.4% (86 subjects) rated their own diet as either very healthy or healthy and 18.8% (57 subjects) considered their diets to be unhealthy. The majority, however (160 subjects, 52.8%) considered their diets to be neither unhealthy nor healthy. The subjects who perceived their diets to be neither unhealthy nor healthy had a significantly higher (P<0.05) percentage of food energy from fat (37.3%) than those who perceived their diet to be healthy (34.4%). However, those rating their diet as unhealthy had a percentage of food energy from fat of 35.9%.

The majority (67%) of subjects agreed with the statement 'I know which foods are healthy', 9.5% disagreed and 22.8% neither agreed nor disagreed. This was reflected in responses to an open question which asked subjects to state three things they could do to improve their diet. Assuming that knowledge of healthy foods is a prerequisite to accurately rating one's diet as healthy or unhealthy, the diet of the 70 subjects who classed their diet as healthy and also agreed with the statement 'I know which foods are healthy' were compared with the remainder of the population sample. A significant difference in mean percentage energy from fat of 2.2% (P 0.01) was found (34.5% and 36.8%, respectively).

This indicates that, at least with respect to fat intake, individuals who rate their diet as healthy do so correctly. Although these differences in fat intake are small, they are significant in meeting the target of <35% food energy from fat (Department of Health, 1992). However, the fat intake of people who perceived their diets to be unhealthy was only marginally higher than the target for fat and not significantly different from the fat intake of those who perceived their diets to be healthy. Reasons behind why these people perceive their diets to be unhealthy when their intake of fat is similar to that of those people perceiving their diet as healthy, and other aspects of the diet, for example intake of fruit and vegetables, warrants further investigation.

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MAFF 1997 A Photographic Atlas of Food Portion Sizes. London: MAFF Publications.
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Is measurement of iron intake in nutritional epidemiology impaired by use of standard values? By B. BRATLEY, D. GREENWOOD, V. BURLEY and J. CADE, *Nutrition Epidemiology Group, Nuffield Institute for Health, 71–75 Clarendon Road, Leeds LS2 9PL*

Fortification of breakfast cereals means that these products contribute significantly to iron intake in the UK (Gregory *et al.* 1990). Accurate study of iron intake from breakfast cereals is limited by the rapid introduction of new products on to the market, and food tables quickly become outdated. The removal of sources of non-differential dietary exposure error in order to strengthen estimates of disease–diet relationship is one of the challenges facing nutritionists. This study aims to evaluate the effect of including brand-level nutrition information in a study of iron intake.

Data on the iron content of 128 fortified breakfast cereals (FBCs) available in Leeds were collected through labelling information and by contacting manufacturers. A random sample of 4 d dietary diaries from 298 participants in the UK Women's Cohort Study (Greenwood *et al.* 2000) formed the study group. Only sixty consumers of FBCs provided brand information and these diaries were analysed using standard values (Paul & Southgate, 1992) and branded information, to gain a profile of iron intake.

	RSC databank analysis	Brand specific analysis
Total mean iron intake (mg)	13.8 (5.0)	13.5 (4.7)
Iron from FBC (mg)	3.6 (4.4)	3.2 (3.6)
Cereal iron as a % of total iron	22.7 (16.3)	21.2 (15.2)

(Standard deviations in parentheses.)

There is a great deal of variation in the amount of fortification of breakfast cereals, even within similar types of product. Although both analyses generated similar mean total iron intakes (mean difference = 2%), there is poor agreement between the two methods of measurement (Bland & Altman, 1986) at the individual level. Use of standard values over- or under-estimates total iron intake by 21% or 18%, respectively. Although these data suggest that the onerous task of collecting brand-specific information on iron content for large nutrition epidemiology studies is unnecessary, the degree of individual variation has implications for studies that aim to match up individual intake and health outcomes. Around one-quarter of subjects were misclassified to the wrong tertile of iron intake using standard values for iron content.

In our sample, FBCs provide up to one-fifth of total iron intake; this figure may be of greater significance in those whose diets are of marginal quality. Furthermore, although subjects in the current study were asked to state brands, only half did so. Given the range of fortification of FBCs it is apparent that provision of brand information is necessary to gain a true reflection of intake.
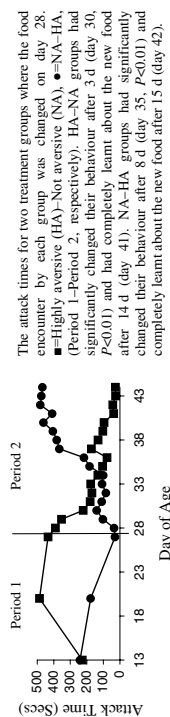
These data highlight the need for caution when assessing individual dietary adequacy based on analysis using standard food tables, due to the potential for misclassification, particularly of high and low consumers. Researchers and those concerned with providing dietary advice should be aware of the large differential in iron levels in breakfast cereals; a standard portion (Crawley, 1994) of bran flakes may provide as little as 12% and as much as 66% of the RNI, depending on brand.

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The rate of avian relearning of the association between sensory and nutritional properties of food. By S.L. HANNAH[1], J.M. FORBES[1] and J.R.G. TURNER[2], [1]*Centre for Animal Sciences, LIBA and* [2]*Centre for Ecology and Evolution, School of Biology, University of Leeds, Leeds LS2 9JT*

After experiencing a food, an animal can relate the sensory properties, such as visual and olfactory, known as the Conditioned Stimulus (CS), with the consequences of ingesting it, known as the Unconditioned Stimulus (US). This is essential for the successful diet selection of an animal as it can learn of the defensive properties possessed by the potential food (i.e. toxic content, sting or imbalance of nutrients), and prevent further discomfort by avoiding or limiting its intake. If the animal encounters a novel food with the same CS as a food that it is already familiar with, but with a different US, some time is required for the animal to learn of the new CS–US association. Past work (Covasa & Forbes, 1994) has illustrated how chickens learn to avoid a coloured food when paired with injections of nausea-inducing cholecystokinin and favour a differently coloured food paired with injections of saline. The authors then reversed the colours and found that the birds required 6–9 d to learn the new CS–US associations and fully alter their behaviour. Although this experiment begins to show an insight into the learning process, the situation some animals naturally face differs from this experimental condition. In such situations as mimicry in prey species, where one harmless species has evolved to look like another toxic species, the animal does not have contrasting visual cues that could aid the learning of the new CS–US associations and so speed up the process.

In this experiment, chickens were given normal chick crumb *ad libitum*, except for 2 h per d during period 1 (see Figure), when they were given a test food, and 5 min per d during period 2 (see Figure), when they were given a second test food. The two test foods were: non-aversive (NA), consisting of chick crumb; and highly aversive (HA), consisting of 50% chick crumb, 50% ground wheat to cause a decrease in protein content and 1% quinine sulphate (w/w). Both were coloured using a red food dye and were visually identical. Two treatment groups were formed, each consisting of two replicate groups of eight birds. The treatments were HA–NA and NA–HA (test food during period 1–test food during period 2, respectively). The time taken for the birds to learn of this change of US and completely alter their feeding behaviour towards the new food was studied.

The attack times for two treatment groups where the food encounter by each group was changed on day 28. ■=Highly aversive (HA)–Not aversive (NA), ●=NA–HA, (Period 1–Period 2, respectively). HA–NA groups had significantly changed their behaviour after 3 d (day 30, *P*<0.01) and had completely learnt about the new food after 14 d (day 41). NA–HA groups had significantly changed their behaviour after 8 d (day 35, *P*<0.01) and completely learnt about the new food after 15 d (day 42).

Once the food had been changed (period 2), the birds in both groups began to alter their feeding behaviour. The group where the US became more aversive (NA–HA) significantly increased their latency to attack (*P*<0.01) from 30 to 459 s (circles in Figure). In contrast, the group where the US became less aversive (HA–NA) significantly decreased their latency to attack (*P*<0.01) from 434 to 34 s (squares in Figure). It took 14–15 d, at one encounter per day, for the birds to completely adjust their behaviour towards the second food and reach a constant attack time. There is extensive literature on conditioning, little which pays attention to the kind of ambiguous situation presented by mimicry. In this experiment the birds had only the one CS of the test food to associate with the change in US. This has demonstrated that the time required for the birds to learn of the change in food is prolonged compared with the results from previous work, in which changes in CS have been accompanied by changes in US, which would therefore aid and speed up the learning process.

Covasa M & Forbes JM (1994) *Physiology and Behavior* **56**, 39–49.

A profile of the food beliefs of obese people in primary care. By H. MOORE[1], D. GREENWOOD[2], P. TOVEY[3] and A.J. ADAMSON[4], [1]*Centre for Research in Primary Care,* [2]*Sub-unit for Medical Statistics,* [3]*School of Healthcare Studies, University of Leeds and* [4]*Human Nutrition Research Centre, University of Newcastle*

The prevalence of obesity in England stands at 17% for men and 21% for women (Prescott-Clarke & Primatesta, 2000). Primary care has been identified as a key provider of treatment (National Audit Office, 2001). Little is known about the food beliefs/attitudes and nutritional knowledge of obese people, information which is crucial to the development of successful interventions.

The food beliefs of 756 obese people, recruited from forty-three general practices in north-east England, were assessed between January and April 2000. Subjects were recruited to take part in an ongoing randomized trial to evaluate an intervention to improve the management of obesity by primary care teams (PCTs). Members of the PCTs asked consecutive patients (BMI≥30; aged 16–64) to join the trial, as they consulted over a 6-month recruitment phase and prior to randomization. Food beliefs were gathered using the 'Irrational Food Beliefs' (IFB) self-completion questionnaire, previously validated on a Canadian population (Osberg *et al.* 1998). IFBs were defined as "cognitively distorted, unhealthy beliefs pertaining to food (e.g. food is my only source of pleasure)". The 57-item questionnaire was adapted for an English sample. Subjects used a 4-point scale to rate the extent to which they agreed or disagreed with statements about food. Statements were classified as Irrational or Rational and the sum of scores on both scales was calculated for each subject.

Baseline data were collected on 794, of which data on 756 (95%) were available. Mean age of the sample was 49 years, and 75% were female. BMI ranged from 25 to 67 (mean 37, sd 5.8), values <30 representing weight lost between recruitment and baseline assessment. Food beliefs classified as irrational included: "I can't live without my favourite food" and "Being overweight is genetic": 25% and 12% of subjects, respectively, agreed or strongly agreed with these statements. Food beliefs classified as rational included "Grilling meat is a healthy way to cook it": 96% agreed or strongly agreed with this statement. In general, the sample agreed with statements classified as rational, and did not agree with irrational statements. As would be expected, there was also a negative, although weak, association between Irrational and Rational Food Beliefs (Kendall's τ=0.10, *P*<0.01). Investigation of the relationship between food beliefs and BMI demonstrated that both irrational (Kendall's τ=0.07, *P*=0.03) and rational (Kendall's τ= 0.05, *P*=0.05) beliefs were positively but weakly associated with BMI. An increase of 10 points (range 38–152 points) on the irrational food belief scale was associated with a 1% (95% CI: 0–2%) increase in BMI; whilst an increase of 10 points on the rational food belief scale (range 11–44 points) was associated with a 3% (95% CI: 0–5%) increase in BMI.

The sample was drawn from practices which had opted to join the 'obesity trial', and the participants themselves may have been more 'food aware' than those who did not join, both of which have implications for generalizability. The obese people held largely rational food beliefs, endorsing sound nutritional principles and holding relatively few irrational food beliefs. This has implications for the development of primary care interventions, which are often based on nutrition education and correction of inappropriate food attitudes. People with the highest irrational food scores tended to be relatively more obese. However, rational beliefs were also positively associated, although the magnitude of both relationships was small. Amongst obese people, high levels of both rational and irrational food beliefs were associated with increasing obesity.

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Associations between fruit and vegetable, starch and fat consumption? By P.J. CURTIS, A.J. ADAMSON and J.C. MATHERS, *Human Nutrition Research Centre, University of Newcastle upon Tyne, Wellcome Laboratory, Queen Victoria Road, Newcastle upon Tyne NE14LP*

The Department of Health (1992) target for fat intake of <35% food energy (%FE) by 2005 contrasts with current UK average intake of about 38%FE (MAFF 2000). Increasing starchy foods and fruits and vegetables (F+V) consumption may help reduce fat intake. WHO (1990) set a European goal of >40 %FE from complex (starchy) carbohydrates and 400g/d of F+V (including starchy F+V), which equates to at least five 80g portions/d of F+V (National Heart Forum 1997). The World Cancer Research Fund (WCRF, 1997) promotes intakes of >7% energy from F+V (excluding starchy F+V). Little is understood about how starch and F+V intakes interact.

Prior to entry into the dietary intervention of the Newcastle-based Family Food and Health Project (Adamson et al 2000), participants completed a 3-d estimated food diary. Participants were interviewed using a photographic atlas of food portion sizes to quantify intake (MAFF, 1997) and nutrient composition was determined using standard UK food tables with additions. Results are presented for 244 adult subjects (aged 16–61 years) for whom mean energy intake was >1.1 times estimated BMR (Goldberg et al. 1991)

Mean %FE from fat, starch and F+V were 36.5%, 27.3% and 5.8% respectively. Mean F+V intake was 352g/d (median 316g/d). 33% of subjects consumed either >400g/d or >7%FE from F+V. Regression analysis showed a significant inverse relationship between %FE from fat and; %FE from F+V (*P*<0.01, R= −0.34), %FE food energy from fruit independently (*P* <0.01, R = −0.38) and F+V in g/d (*P* <0.01, R=−0.25). There was a weak negative correlation between vegetable intake and both fat (*P* <0.06) and starch (*P* <0.07) intake. However, starch intake was not correlated with intakes of total F+V.

The population was then grouped into quartiles of fat and starch consumption (based on %FE), with quartiles 1 and 4 being the lowest and highest consumers respectively. Participants in the highest fat quartile (40.8 to 53.8 %FE) derived significantly less %FE from F+V, %FE from fruit, and g/day from F+V (*P*<0.01) than all other quartiles. Relatively high starch intakes, represented by quartile 3 (26.8 to 30.5 %FE), were associated with significantly higher F+V intake and fruit intake independently (%FE and g/d) than the lowest starch consumers (*P* <0.01). Consumers in quartile 3 ate 379g/d and 7.1%FE from F+V. However, the highest starch consumers (30.6 to 43.6 %FE) ate significantly less F+V and fruit independently (%FE and g/d) than quartile 3 (*P* <0.01), and had the lowest total F+V intake of all quartiles. Vegetable intake was not associated with either fat or starch consumption.

In conclusion, adults consuming higher fat diets ate significantly less F+V (%FE and g/d) than those with lower fat diets. Fat consumption was particularly inversely associated with fruit intake. Relatively high starch diets (quartile 3) were associated with F+V intakes that almost both the WCRF and WHO recommendations, however there may be a point at which further dietary starch is associated with reduced F+V intake. This analysis will be repeated post dietary intervention to evaluate whether advice to increases starchy foods has any effect on F+V consumption.

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The dietary intake of free-living and institutionalized elderly people. By C. EASTWOOD[1], G.J. DAVIES[1] and P.W. DETTMAR[2], [1]Nutrition Research Centre, South Bank University, 103 Borough Road, London SE1 0AA and [2]Reckitt Benckiser, Dansom Lane, Hull HU8 7DS

The latest UK representative nutritional study of older people is the National Diet and Nutrition Survey: people aged 65 years and over (Finch et al. 1998). Although the survey compared dietary intakes of free-living (FL) with institutionalized (INS) volunteers over 4 d, the dietary assessment methods were different for the two groups. In the FL group, food intake was assessed by the weighed inventory method (Bingham, 1987). In the INS group, the investigator weighed only one main meal per day and the volunteer or the care staff recorded food intake based on estimations of portion sizes. In view of this, the aim of the present study was to compare the dietary intakes between FL and INS elderly people using the weighed inventory method for dietary assessment in both groups.

Ethical approval was obtained from South Bank University Ethics Committee. Fifty FL volunteers (mean age 74 years, 42% male) and forty-two INS volunteers (mean age 84 years, 36% male) were recruited in the London area. Food intake was measured using the 4 d weighed inventory method, undertaken either by the volunteers (in the FL group) or by the investigator (in the INS group). Foods were weighed by a simplified cumulative method (Marr, 1965). Nutritional analysis was carried out using the computer program Dietplan5 for Windows.

Mean (SD) per day	FL (n 50)	INS (n 42)	P value
Energy (MJ)	7.7 (1.8)	6.5 (2.1)	0.032*
Protein (% E)	15.5 (3.3)	14.4 (2.3)	0.087
Fat (% E)	33.4 (7.6)	37.0 (5.2)	0.057
Carbohydrate (% E)	46.9 (7.9)	47.2 (5.8)	0.665
NSP (g)	15.5 (6.4)	7.3 (2.5)	<0.001***
Food/fluid (g)	2292.5 (589.2)	1945.2 (822.8)	0.091
Water (g)	1777.0 (562.7)	1599.8 (744.2)	0.337

Significant differences between FL and INS: *$P<0.05$, ***$P<0.001$, using ANOVA with gender and age as co-variates.

The present study shows that mean energy intake was significantly lower in the INS group than in the FL group, possibly due to the fact that INS volunteers tended to eat less food. However, in the NDNS study, INS volunteers had slightly higher energy intake than FL volunteers, probably due to over-reporting by care staff and by volunteers. INS women in the present study had significantly lower energy intakes (5.6 v. 6.9 MJ per d), percentage of energy from carbohydrate (48.2 v. 51.2) and NSP (6.9 v. 9.5 g per d) than the INS women in the NDNS study. Moreover, in our INS group, the mean energy intake was below the Estimated Average Daily Requirement and the percentage of total energy derived from fat was slightly higher than the DRV (Department of Health, 1991). It was of particular concern that the mean NSP intake in both groups in the present study was below the DRV (population average of 18 g/d), with the intake in the INS below the DRV individual minimum of 12 g/d and significantly lower than the FL group.

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Relationship between consumer beliefs towards starchy foods and starch consumption. By A. SPENDIFF, A.J. ADAMSON, P.J. CURTIS, A. JONES and J.C MATHERS, Human Nutrition Research Centre, University of Newcastle, Wellcome Laboratories, RVI, Queen Victoria Road, Newcastle upon Tyne NE1 4LP

The UK target for fat intake by 2005 is ≤35% of food energy (Department of Health, 1992). At present, fat contributes 38% of energy (MAFF, 2000). An increased consumption of foods high in complex carbohydrates (starchy foods) is recommended to achieve the reduction in fat intake required. The Newcastle Family Food and Health project is an intervention study aimed at increasing the consumption of foods rich in starch (Adamson et al. 2000). Prior to entry into the intervention, 321 adults (aged 16 years +) completed a 3 d food diary followed by interview during which food photographs were used to quantify portion sizes. Standard UK food tables were used to calculate mean daily percentage energy from starch. Subjects also completed a questionnaire which included quantitative and qualitative assessments of beliefs towards starchy food. A randomly selected sub-sample of forty adults took part in a semi-structured interview.

Responses to eleven 'agree/disagree' questions on belief's towards starchy foods were combined to produce an overall attitude score (–11 to +11). Spearman's coefficient of rank correlation was used to test the relationship between overall attitude score and percentage energy from starch. Independent sample t-tests were used to test the relationship between responses to individual questions and percentage energy derived from starch. For the qualitative data, a theme analysis was carried out on the responses to open questionnaire questions that asked what people thought about starchy foods. Transcribed interviews were analysed for references to starchy foods using NUD*IST (Qualitative Solutions and Research Pty Ltd.).

The mean percentage energy derived from starch was 25.7%. There was a generally positive attitude to starchy foods with a mean score of 7.5 (range –3 to +11). More than 89% of the subjects believed starchy foods to be 'good value for money', and that they 'fill you up' and did not believe that these foods were 'of poor nutritional value', 'difficult to cook' or 'take a long time to prepare'. Questions that prompted the most mixed responses were whether starchy foods are 'fattening', 'boring' or 'taste good', whether they 'should be main part of all meals' and whether 'people should eat more'. No relationship was found between overall attitude to starchy foods score and consumption of starchy foods. None of the responses to individual belief questions about starchy food showed any significant relationship with starch intake; only taste approached significance.

These foods:	Agree (A, %)	Disagree (D, %)	Mean difference % E from starch (A–D)	P value
Are fattening	22.3	70.9	–0.3	0.68
Are boring	22.6	71.2	0.4	0.64
Taste good	79.3	15.5	1.6	0.07
Are good for you	87.9	7.1	–1.7	0.18
Should be the main part of all meals	60.4	33.7	0.5	0.49
Most people should eat more of these	73.1	18.3	0.4	0.65

People who believed starchy foods are 'good for you', that they 'should be the main part of all meals' or that 'most people should eat more', did not consume any more starch, as percentage of energy, than those who disagreed with these statements. Analysis of qualitative data (questionnaire and interviews) suggests that people do not perceive starchy foods as a homogeneous food group so that caution should be used in interpreting quantitative questions about starchy foods. Among this population there was confusion regarding the health implications of a diet high in starchy foods and a limited understanding of the quantities of starchy foods which are desirable.

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Diet and folic acid in the first trimester of pregnancy. By S.C. LANGLEY-EVANS and A.J. LANGLEY-EVANS, *Human Nutrition and Metabolism Group, Division of Health and Life Sciences, University College Northampton, Boughton Green Road, Northampton NN2 7AL*

As a key element of a strategy for the prevention of neural tube defects, the Department of Health recommends that women who are pregnant or considering conception should take a supplement of 400 μg folic acid daily for 3 months prior to pregnancy and for the first 3 months of pregnancy (Joint Department of Health Expert Advisory Group, 1992). Recent surveys have indicated a rising awareness of this advice among women of child-bearing age (Raats et al. 1999). Following the recommendations from the Department of Health, folic acid sales increased by 100-fold over 4 years, although there was no appreciable decline in the numbers of neural tube defects over the same period (Kadir et al. 1999). The present study evaluates folate consumption among women in the first trimester of pregnancy.

A group of 255 pregnant women in the first trimester of pregnancy, attending an antenatal ultrasound clinic, were recruited to the Northampton Diet and Pregnancy Study. The mean age of the women at recruitment was 27.9 years (range 16–42 years) and the mean gestation was 10.5 weeks (range 7–15 weeks). All women completed a simple questionnaire concerning social class indicators and the use of nutritional supplements. The women were provided with a 5 d estimated food record for completion at home A total of 149 diaries were returned and analysed using Comp–Eat version 5. A total of 195 women (77%) were consuming nutritional supplements on a daily basis. Of these, 68% were consuming a single 400 μg folic acid supplement as recommended by the Department of Health, 22% were consuming pregnancy multivitamins and 3% were consuming standard multivitamin tablets. The use of folic acid supplements was greater among women over the age of 21 (71% in over 21 years age group, 46% in under 21 years age group, P 0.011). A lower prevalence of folic acid supplementation was noted among women in social classes III, IV and V.

Social class	No supplement		Folic-acid-containing supplements	
	(n)	(%)	(n)	(%)
I	4	19	15	71
II	16	17	69	73
III	9	25	25	67
IV	12	30	25	53
V	6	32	11	63

Estimates of dietary folate acid consumption varied between 48 and 480 μg/d (mean 243 μg/d). Folate consumption did not vary with age or social class. The main sources within the diets of this population of pregnant women were cereals, bread, orange juice and milk. As these are mostly foods which are consumed uncooked, the loss of folate due to heat lability can be assumed to be low. Dietary sources thus provide approximately 61% of folate requirements during this stage of pregnancy. Within this study, 23% of the women studied were not consuming a folic acid supplement and 16% had folate intakes below the RNI for pregnancy.

These data are consistent with previous estimates of folic acid supplement usage among women in early pregnancy. Variation in uptake of advice related to age and social class suggests that targeting of nutritional advice to younger women from low-income backgrounds should be a priority. The significant number of women with folate intakes below the RNI adds weight to the argument that the range of foods fortified with folate should be increased.

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Fruit and vegetable intake and perceived chewing ability of complete denture wearers. By J. BRADBURY, J.M. THOMASON, N.J.A. JEPSON, A.W.G. WALLS, P.F. ALLEN and P.J. MOYNIHAN, *The Dental School, University of Newcastle upon Tyne, Newcastle upon Tyne NE2 4BW*

Complete denture wearers have reduced chewing ability compared to people with natural teeth (Krall et al. 1998). Studies of food and nutrient intake, including the National Diet and Nutrition Survey (NDNS; Steele et al. 1998), have shown a lower intake of fruit and vegetables, in particular, those fruits and vegetables which denture wearers identify as a problem, such as apples and tomatoes (Ettinger, 1973; Steele et al. 1998).

The results presented are from the baseline data of a randomized controlled dietary intervention study delivered to complete denture wearers requesting replacement dentures and attending Newcastle Dental Hospital. The aims were to measure intake of fruit and vegetables, assess perceived chewing ability, examine the relationship between these variables, and assess whether the perceived importance of being able to eat as much fruit and vegetables as desired was related to intake.

Seventy-two patients aged 45–79 years (mean 67 years) completed a 3 d estimated food diary, and a questionnaire (based on the NDNS) to assess perceived chewing ability. A 'chewing ability score' was obtained by summing eight questions (possible score 7–50), with a higher score indicating greater chewing difficulty and less satisfaction. Additional questions asked the participants to rate the importance of being able to eat as much fruit, cooked and raw vegetables as they wanted. Median intakes (and range) were determined for fruit, vegetables, fruit juices, pulses, and total fruit and vegetable intake (including juices and pulses) (see table). A Spearman correlation was used to examine relationships between chewing ability and intake, and between perceived importance of eating fruit and vegetables and intake.

Fruit and vegetable intake was less than 400 g/day for 61.1% of participants, 80.6% drank no fruit juice and 22.2% ate no fruit. Of the patients, 8.5% were very satisfied with their existing dentures, 21.1% satisfied, 39.4% unsatisfied, and 31.0% very unsatisfied. No relationship between chewing ability and intakes of fruit, fruit juices, vegetables, pulses or total fruit and vegetables was found. The perceived importance of being able to eat fruit, cooked and raw vegetables was positively correlated with intake of fruit, vegetables, fruit juices and total intake of fruit and vegetables, but not pulses (see table).

	Intake/d Median (g)	Range (g)	'Being able to eat as much*...as I like is very unimportant/very important'					
			*fruit		*cooked vegetables		*raw vegetables	
			r	p	r	p	r	p
Fruit	112.7	0–897	0.36	0.00	0.39	0.00	0.28	0.02
Fruit juices	0.0	0–284	0.13	0.29	0.13	0.28	0.26	0.03
Vegetables	155.3	16–540	0.16	0.18	0.41	0.00	0.24	0.04
Pulses	0.0	0–200	−0.05	0.70	−0.06	0.60	−0.12	0.32
Total	333.3	22–1530	0.33	0.00	0.44	0.00	0.35	0.00

There was a wide variation in the quantity of fruit and vegetables consumed by these denture wearers. Despite the majority of participants not being satisfied with their dentures, no relationship was demonstrated between perceived chewing ability and intake of fruits or vegetables. Other factors, such as perceived importance of being able to eat fruit and vegetables, may be more influential.

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Low birth weight babies: maternal diets of preterm and small for gestational age babies. By G.A. REES, W. DOYLE and M.A. CRAWFORD, *Institute of Brain Chemistry and Human Nutrition, University of North London, 189 Well Street, London E9 6QU*

Maternal nutrition both prior to and during gestation is of known aetiological importance to fetal growth. Although there is an extensive literature on factors affecting fetal growth, there are fewer reports on the relationship between nutrition and duration of gestation. Reports suggest that maternal diet is a less important determinant of gestational duration than of fetal growth (Kramer *et al.* 1992).

The aim of this work was to investigate the diet of mothers who had recently had a low birth weight (LBW) baby (<2.5 kg) and to look for differences in the dietary intake of women whose infants were either preterm (<37 weeks) or term, thus identifying 'at risk' nutrients for each group.

The study took place in Hackney, East London, one of the most deprived boroughs in the UK, where almost 10% of live births are of LBW. Women who had given birth to a LBW baby were recruited from the postnatal wards as part of two inter-pregnancy nutrition intervention trials (Doyle *et al.* 1999; 2001). Mothers were contacted again at 3 months post-partum and asked to keep a 7 d food record using household measures. The nutrient content of the diets was calculated using Foodbase, a nutritional analysis program based on Royal Society of Chemistry data. Gestational age was assessed by maternal dates supported by paediatric clinical assessment or ultrasound scan where possible. Intrauterine growth retardation was assessed using the Yudkin *et al.* (1987) centile chart.

165 women completed diet diaries to a satisfactory standard for analysis. It was found that 58% of the LBW babies were preterm. The mean age of the subjects was 28.8 (range 16–43) years. There was no significant difference associated with age, social class, maternal height, BMI, weight gain during pregnancy or reported number of cigarettes smoked during pregnancy. A significantly higher proportion of African mothers had preterm births than any other ethnic group (*P*<0.001). The average daily energy and nutrient intakes of women who had term LBW babies was generally higher than those with preterm babies. In particular, intakes of energy, fat, *n*-6 fatty acids, fibre, calcium, magnesium and potassium were significantly higher in mothers of term babies. No significant dietary differences were found between mothers of babies above and below the 10th centile.

		LBW preterm (n 96)	LBW term (n 69)	P value	Reference group (n 165)*
Energy	kcal	1676	1836	0.024	1974
	MJ	7.03	7.70	0.025	8.26
Fat	g	69.0	79.8	0.004	88.9
n-6 Fatty acids	g	9.52	10.9	0.035	11.9
Fibre (Englyst)	g	9.28	11.0	0.021	19.2
Calcium	mg	634	744	0.013	953
Iron	mg	10.0	11.0	–	12.9
Magnesium	mg	215	237	0.050	286
Zinc	mg	7.45	8.14	–	10.2
Potassium	mg	2258	2490	0.037	–

* Composition of diets of women who had normal birth weight babies (3.5–4.5 kg) (Doyle *et al.*, 1999).

It is likely that there are many factors responsible for premature birth, but our data support the view that there is a nutritional component in prematurity, most consistently in maternal intakes of magnesium and calcium.

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Changes in premature infant lutein and zeaxanthin concentrations during the early weeks of life. By V.C. JEWELL[1], C.B.D. MAYES[2], R. TUBMAN[3], C.A. NORTHROP-CLEWES[1] and D.I. THURNHAM[1], [1]*Northern Ireland Centre for Diet & Health, University of Ulster, Coleraine BT52 1SA,* [2]*Department of Child Health, Queen's University, Belfast and* [3]*Neonatal Intensive Care Unit, Royal Maternity Hospital, Belfast, BT12 6BB*

Premature birth (or birth before 37 weeks) is the most common cause of neonatal mortality, morbidity and long-term disability. Premature infants are particularly susceptible to a number of oxidant stress related conditions including retinopathy of prematurity (ROP), strabismus and periventricular leucomalacia, which often also involve neurological dysfunction. Carotenoids are antioxidants and may play a role in protecting infant tissues from oxidative damage, particularly the retinal epithelium. The carotenoids lutein and zeaxanthin are located in the retinal pigment epithelium and are believed to play a role in protecting it against oxidative and light damage (Bone *et al.* 1985). Lutein and zeaxanthin are two yellow carotenoids that give the macular area of the eye its colour, and are selectively accumulated in this part of the eye. Lutein is one of the five most common carotenoids found in the diet with concentrations in the blood of about 20–30% of total carotenoids, but zeaxanthin concentrations are only about 2–4%. Lutein may be actively secreted into milk rather than by passive diffusion as the other carotenoids appear to be. The macular pigments are of dietary origin and green leafy vegetables are the primary source; however, for the human infant breast milk is the main dietary source of lutein and zeaxanthin until weaning occurs.

It is thought that lutein and zeaxanthin diffuse across the placenta in amounts controlled by the concentration in the mother's plasma since there are direct correlations between the respective amounts in mothers' and babies' plasma (Jewell *et al.* 2000). Our most recent study concurs with this finding. To date, twenty-six mothers and their premature infants have been recruited and blood samples were taken from the mother at birth, from the cord and from the infant every 2 weeks until discharge. Breast milk samples were obtained for those infants who were breast-fed. Median (interquartile range) gestation was 31 (24–35) weeks and birth weight was 960 (637–2664) g. The table shows the median and interquartile range of lutein and zeaxanthin concentrations in the mothers and their premature infants. Infant concentrations of both lutein and zeaxanthin were significantly lower in cord blood than maternal values (*P*<0.01) and remained low in the infants until 5 weeks of life. Maternal lutein correlated with infant lutein (*n* 26, *r* 0.271, *P* 0.05). The same correlation was observed for zeaxanthin (*n* 26, *r* 0.271, *P* 0.05).

Paired maternal and premature infant plasma concentrations of lutein and zeaxanthin (µmol/l).

	Maternal (n 26)	Cord (n 26)	1 week (n 14)	3 weeks (n 6)	5 weeks (n 3)
Lutein	0.156 (0.072–0.302)	0.045 (0.016–0.102)	0.055 (0.011–0.113)	0.055 (0.016–0.13)	0.084 (0.031–0.142)
Zeaxanthin	0.038 (0.009–0.101)	0.010 (0.002–0.029)	0.007 (0.00–0.019)	0.004 (0.00–0.011)	0.014 (0.00–0.02)

Median (interquartile range) is shown.

Breast milk provides a variety of nutrients not universally found in bovine milk or infant formula, and is therefore the preferred source of nourishment for infants. Carotenoids are often abundant in breast milk. They are antioxidants and may offer enhanced protection against infection. Lutein levels in human milk are two to three times higher than those of β-carotene, whereas the comparative concentrations in the mothers' blood are approximately the same. To date seven infants have received breast milk while in the Unit but no difference in plasma carotenoids was found. Overall, lutein concentrations showed a tendency to increase from birth, while zeaxanthin dipped during weeks 1–2.

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Effect of feeding a low-protein diet on liver and plasma phosphatidylcholine *n*-3 fatty acid concentrations in the adult rat. By G.C. BURDGE, P. WRIGHT, R. DUNN, S.A. WOOTTON and A.A. JACKSON, *Institute of Human Nutrition, Southampton General Hospital, Tremona Road, Southampton SO16 6YD*

Accumulation of docosahexaenoic acid (DHA, 22:6n-3) is critical for the development of both brain and retina. During pregnancy and lactation the mother is the sole source for supply of pre-formed DHA to the offspring. We have shown previously that pregnancy is associated with a selective increase in maternal plasma phosphatidylcholine (PC) DHA concentration in both women and rats (Burdge *et al.* 1994; Postle *et al.* 1995) which may facilitate supply of DHA to the fetus. Dietary protein intake in pregnancy impairs fetal growth and results in elevated in blood pressure in the offspring (Langley-Evans & Jackson, 1994). The effect of dietary protein intake on *n*-3 fatty acid status in adult animals has not been described. We have investigated the effect of a reduced protein diet on adult liver and plasma PC *n*-3 fatty acid contents in non-pregnant (NP) and pregnant (P) rats.

Female Wistar rats (*n* 5/group) were fed either diet with 18% or 9% casein (containing 10% w/w corn oil with no detectable DHA) (Langley-Evans & Jackson, 1994) either from conception until 20 d gestation, or for 21 d (NP group) when the animals were killed. Blood was collected by cardiac puncture, and plasma isolated by centrifugation. Livers were frozen immediately in liquid nitrogen. Liver and plasma PC was isolated by solid phase extraction (Burdge *et al.* 2000) and fatty acid methyl esters resolved and quantified by gas chromatography with flame ionization detection. Statistical comparisons were by analysis of variance.

DHA was the principal *n*-3 fatty acid in both liver and plasma PC in NP and P animals on either diet. There was no significant effect of pregnancy or diet on plasma or liver α-linolenic, eicosapentaenoic or docosapentaenoic acid concentrations (not shown). Liver PC DHA content was not altered significantly by diet or pregnancy. There was a significant increase in plasma PC DHA concentration in the P rats fed the 18% casein, but not the 9% casein, diet compared with NP animals. There was no significant effect of diet on plasma PC DHA content in NP animals.

	DHA concentration (g/100 g total PC fatty acids)			
	Non-pregnant		Pregnant	
	18%	9%	18%	9%
Dietary protein content	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Tissue								
Liver	7.9	0.6	7.7	0.7	7.9	1.4	6.8	1.3
Plasma	4.6*	0.2	4.6	0.6	6.8**	1.2	4.6	1.2

Values significantly different (*P*<0.05) *between NP and P animals on the same diet, or **between diets.

Pregnancy and dietary protein content produced different effects on liver and plasma PC DHA. Since the liver is the primary source of plasma PC, this suggests differential handling of DHA destined either for incorporation into hepatic or lipoprotein pools. Pregnancy was associated with increased plasma PC DHA concentration in the 18% group, which agrees with our previous data (Burdge *et al.* 1994), but not the 9% group. Together these data suggest that while there was no apparent effect of dietary protein on plasma PC DHA in NP animals, reduced protein intake constrained the capacity of maternal rats to raise plasma DHA to meet the increased demands of pregnancy. If such constraint occurred in human pregnancy where there is a sustained demand for DHA, this may result in a substantial deficit in DHA accumulation into fetal tissues.

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Postnatal ontogeny of cytochrome c, the voltage-dependent anion channel (VDAC) and uncoupling protein 1 (UCP1) in ovine brown adipose tissue (BAT). By A. MOSTYN, T. STEPHENSON and M.E. SYMONDS, *Academic Division of Child Health, School of Human Development, University Hospital, Nottingham NG7 2UH*

Mitochondria are established to have a central role in energy metabolism, BAT mitochondria contain the unique protein UCP1 which generates heat rapidly after birth (Symonds *et al.* 1992). In fetal sheep, mRNA abundance and thermogenic activity of UCP1 remain low throughout gestation and peak immediately after birth (Castella *et al.* 1989). VDAC is a general diffusion porin found in the outer mitochondrial membrane (Kirk & Strange, 1998) whose abundance peaks at 1 day of postnatal age. VDAC has a substantial role in the delivery of ATP and ADP across the outer mitochondrial membrane and is therefore important in the energetic and metabolic functions of mitochondria. Cytochrome c is a well-characterized mobile electron transport protein essential in energy conversion that is localized to the mitochondrial intermembrane space (Lehninger *et al.* 1993). The extent to which the development of these key mitochondrial proteins may be related is not known. The present study investigated their ontogeny over the period in which BAT is replaced by white adipose tissue in the lamb.

BAT was sampled from fetal lambs at 145 d gestation and post-neonatal lambs at 4 h, 1, 7 and 30 d after birth (4/5 each group) after administration of a lethal dose of anaesthetic (Na pentobarbitone 200 mg/kg) and frozen immediately in liquid nitrogen. Mitochondria were prepared and analysed using immunoblotting (Schermer *et al.* 1996) with antibodies specific for cytochrome c, VDAC and UCP1 that produced single bands at 16, 35 and 32 kDa, respectively. Results are expressed as a percentage of a reference samples present on all gels. Differences between ages were analysed using a Kruskal-Wallis test.

Age	Cytochrome c (*n* 4)		VDAC (*n* 5)		UCP1 (*n* 5)	
	Mean	SEM	Mean	SEM	Mean	SEM
G 144	158.5	16.9	92.9	7.9	38.5	7.3
4 h	217.6	23.3	106.7	14.3	92.5*	11.6
1 d	406.3*	27.7	173.1**	11.2	138.0*	5.2
7 d	320.8*	16.8	95.1**	11.8	60.14*	7.8
30 d	41.7*	5.9	10.2**	1.1	0*	0

Significantly different between age groups: **P*<0.05, ** *P*<0.01 as measured by Kruskal-Wallis test.

The abundance of each mitochondrial protein peaked at 1 day of age, before gradually declining up to 1 month of age. These parallel changes are coincident with the transition of BAT to white adipose tissue. In conclusion, these similar ontogenic changes indicate that cytochrome c, VDAC and UCP1 may all be critical in ensuring that BAT maintains a maximal rate of heat production after birth.

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The role of luminal nutrition on the incidence of apoptosis in the small intestinal mucosa of the post-lactating rat. By B.E. MURRAY, S. THOMPSON and R.D.E. RUMSEY, *Centre for Human Nutrition and Department of Biomedical Science, University of Sheffield, Sheffield S10 2TN*

Hyperplasia of the mucosa of the small intestine and elevated crypt cell proliferation rates are associated with the marked increase in food intake during lactation in rats (Harding & Cairnie, 1975). At weaning, food intake and cell proliferation return rapidly to normal values. This rapid hypoplasia is associated with an enhanced incidence of apoptosis or programmed cell death (Al-Wahaibi *et al.* 2001). The present experiments use simple dietary manipulation to investigate the role of maintained nutrient density within the small intestine in the institution of these homeostatic mechanisms.

Twelve lactating rats were randomly allocated to one of four treatment groups at the time of weaning. Two of the groups were designated to be killed 7 d after weaning (7 d post-lactation) and the remaining two were designated to be killed 14 d after weaning. After weaning, one group in each pair was offered a highly palatable diet in addition to the normal rat cake. The additional diet consisted of chocolate chip cookies, chocolate buttons and condensed milk amounting to 800 kJ. Body weight and standard rat cake consumption were determined daily. At their allotted time rats were killed under chloroform anaesthesia; the small intestine was removed, rinsed and fixed under constant hydrostatic pressure with acetic acid/alcohol (1:3). Small segments of duodenal and ileal tissue were stained by the Feulgen reaction. Individual villi were dissected from each specimen, their dimensions determined and squash preparations examined for apoptotic figures. Results of the incidence of apoptosis on each villus were presented as a proportion of the total number of normal enterocytes in a standard grid square.

The results of the determinations on apoptotic incidence demonstrate that in duodenal villi from rats on standard rat diet alone the incidence of apoptosis was high both at 7 and 14 d post-lactation, mean incidence of 0.096 (0.021) and 0.079 (0.014) bodies/nuclei/villus (mean (SE)), respectively. The equivalent values obtained for the animals fed the additional diet were 0.033 (0.019) and 0.077 (0.016) at 7 and 14 d (*n* 3). The low value for apoptotic incidence at 7 d post-lactation was statistically significant (*P*<0.05) with analysis of variance. The high-energy diet had no effect on the incidence of apoptosis in ileal villi. The rats fed the special high-density diet maintained their body weights at preweaning levels for the 14 d of the study. Furthermore, the weight of normal rat cake consumed by the special-diet rats was insignificant, suggesting that the special diet was largely preferred.

The lack of an effect on ileal villi suggests that the influence on mucosal kinetics is directly related to the presence of nutrients, as the ileum would receive a diluted supply. The effect on the incidence of apoptosis demonstrates that physiological cell deletion within the mucosa plays a part in the hypoplasia that restores a normal mucosa. The data also suggest that, under normal conditions, nutrients present in the lumen directly affect cell population homeostasis by an action on the apoptotic process.

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Effects of insulin and dexamethasone on stearoyl coenzyme A desaturase mRNA concentrations in ovine adipose tissue. By Z.C.T.R. DANIEL, P.J. BUTTERY and A.M. SALTER, *Division of Nutritional Biochemistry, School of Biosciences, University of Nottingham, Sutton Bonington Campus, Loughborough LE12 5RD*

Of the total fatty acid content of lamb meat, approximately 22% is palmitic acid, 18% stearic acid and 32% oleic acid (Enser *et al.* 1996). Most of the oleic acid is synthesized in the tissue by the desaturation of stearic acid by stearoyl CoA desaturase (SCD). SCD may also play an important role is synthesizing the *cis*-9, *trans*-11 isomer of conjugated linoleic acid (CLA) from vaccenic acid (*trans*-11, C18:1) produced during rumen biohydrogenation of polyunsaturated fatty acids. Thus, increasing the activity of SCD in ovine adipose tissue may significantly improve the nutritional quality of lamb by decreasing the saturated fatty acid content, increasing the oleic acid content and increasing the CLA content. We have previously shown that ovine SCD is produced from a single gene and that tissue SCD mRNA concentrations correlate well with oleic acid content (Ward *et al.* 1998; Barber *et al.* 2000). We have also shown that insulin increases and dexamethasone decreases, the synthesis of monounsaturated fatty acids (MUFA) from acetate, in cultured ovine adipose tissue explants (Salter *et al.* 1999).

The present study was designed to investigate whether the effects of hormones on MUFA synthesis are mediated through expression of SCD. Subcutaneous adipose tissue explants, taken from 9-month-old male Charollais × Mule sheep, were preincubated in M199 media for 24 h and then subjected to the following treatments for 24 h: insulin (20 nM), insulin (20 nM) plus dexamethasone (10 nM) and dexamethasone (10 nM). SCD mRNA levels were determined using a ribonuclease protection assay on 10µg total RNA. Figure A represents three independent experiments using three different sheep and shows that insulin significantly increased SCD mRNA levels (*P*<0.001) while dexamethasone alone caused a significant decrease in SCD mRNA levels (*P* 0.002). When the hormones were added together, the effects of insulin predominated. A clear dose–response effect of insulin on SCD mRNA levels was seen (Figure B).
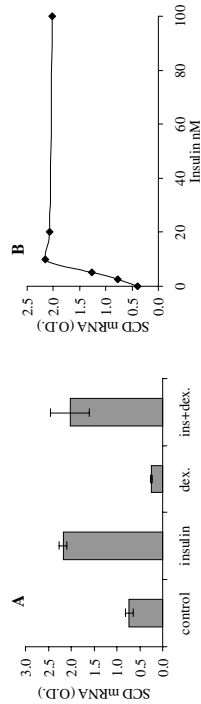
These data clearly show that the changes in MUFA synthesis seen in ovine adipose tissue in response to insulin and dexamethasone are associated with changes in SCD gene expression. If prevailing insulin concentrations could be manipulated *in vivo* by diet, this may result in a significantly improved fatty acid composition of lamb meat.

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The effect of an after-school 'Food Club' on intake of foods and nutrients by children from deprived social backgrounds. By S.A. REVILL[1] and N. SCANLON[2], [1]Food, Consumer Behaviour and Health Research Centre, School of Human Sciences, University of Surrey, Guildford GU2 7XH and [2]Department of Primary Health Care, University of Newcastle, Newcastle upon Tyne NE1 4LP

A barrier to achieving a healthy diet may be the inability or lack of confidence to prepare healthy inexpensive foods (National Food Alliance, 1997). Possession of cooking skills is one of the factors most likely to indicate better diets in low-income families (Dowler & Calvert, 1994).

The objective of this controlled dietary intervention was to measure the effects of an after-school Food Club, which taught children from deprived social backgrounds how to prepare healthy inexpensive foods, on dietary intakes of fruit, vegetables, starchy foods and nutrients.

All children in year 7 (aged 11–12 years) of ten schools in deprived areas of Tyne and Wear were invited to take part. From all volunteers, the twenty pupils in each schools with the highest Townsend scores (index of deprivation, with highest score being the most deprived) were selected. Children from five schools attended an after-school Food Club on one night a week for 20 weeks. Children in the five remaining schools served as controls. Diet was assessed using the 2×3 d estimated food diary and interview technique (Hackett et al. 1983) at baseline (T0) and post-intervention (T1). Data were coded using the 5th Edition of McCance and Widdowsons 'The Composition of Foods' and supplements, and were entered into an Access Database. Intake of nutrients and foods belonging to the five food groups of the Balance of Good Health (Health Education Authority, 1994) were derived using purpose-written programs. Changes within groups (T1–T0) were determined using paired t-test and differences between groups for changes in intakes of foods and nutrients were determined using a t-test. Secondary analyses were carried out by sex.

Eighty-four children in the test group (thirty-one boys and fifty-three girls) and eighty-eight children in the control group (thirty-four boys and fifty-four girls) completed all food diaries. There was no significant difference in Townsend scores between groups. The results are tabulated below.

	Test group						Control group					
	T0		T1		T1–T0		T0		T1		T1–T0	
	Mean	SD	Mean	SD	Mean	SEM	Mean	SD	Mean	SD	Mean	SEM
Energy (MJ)	8.8	2.1	9.2	2.5	0.5	0.3	8.6	2.0	9.3	2.3	0.8**	0.3
% energy fat	36.3	3.5	36.3	3.7	0.3	0.4	35.4	4.0	35.9	3.7	0.5	0.5
% energy saturated fat	12.1	1.9	12.4	2.0	0.3	0.3	11.6	2.3	11.9	2.0	0.2	0.3
% energy total sugar	21.8	4.2	20.1	4.7	-1.6*	0.6	23.2	5.5	20.8	4.3	-2.4*	0.6
% energy NME sugar	16.8	4.0	14.9	4.5	-1.6	0.6*	18.1	5.1	15.3	3.8	-2.7*	0.7
% energy starch	28.2	3.7	29.5	4.3	1.0	0.5*	28.2	4.0	29.5	3.8	1.4*	0.5
Fruit & vegetables (g/d)	129	94	154	98	19.2	13.6	147	101	169	99	20.4	12.9
Starchy foods (g/d)	326	90	369	109	51.1*	15.2	295	77	377	203	83.9*	10.6

*P<0.01 **P<0.05 for within group changes.

The results show that both test and control groups significantly increased intake of starch and starchy foods, and reduced their intake of sugars. However, no significant differences in changes in intake of these nutrients or foods were observed between groups. Analysis by sex showed boys in the test group significantly increased their intake of fruit and vegetables by 75 g/d (P 0.003), whereas boys in the control group and girls in both groups showed no significant change in intake of fruit and vegetables. The food club had a positive impact on fruit and vegetable intake of boys but as other positive dietary changes were observed for both groups these may not necessarily be attributable to attendance at the Food Club.

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Predicting mothers' use of weaning foods: application of the theory of planned behaviour. By M.M. RAATS[1] and N. SCANLON[2], [1]Food, Consumer Behaviour and Health Research Centre, School of Human Sciences, University of Surrey, Guildford GU2 7XH and [3]School of Biomedical and Life Sciences, University of Surrey, Guildford GU2 7XH

The COMA report (1994) discourages the use of wheat cereals on the basis that an infant may develop a food allergy; as a result, baby rice is a popular first weaning food in the UK (e.g. Gibson et al. 1998). Many health professionals believe that the decision to wean should be based solely on the nutritional needs of the baby (Werk & Alpert, 1998). Hunger-related behavioural changes are one of the main rationales for commencing weaning (e.g. Anderson et al. 2001), such behaviours have been identified as, the infant needing more frequent feeds, the infant crying after a feed, and changes in sleeping patterns (Murphy et al. 1998). Morgan et al. (1995) found that mothers thought nutritional content of the foods was important, in terms of a low sugar and salt intake; however, they also noted that 80% of mothers thought that a low fat intake was important. It was suggested that beliefs such as these are based on adult dietary guidelines (Morgan et al. 1995; Savage et al. 1998). The primary aim of this study was to address the relative lack of knowledge about mothers' food choices during weaning, and the attitudinal and motivational factors which impact on intentions regarding food provision for the infant.

Forty-eight mothers with babies aged 3–12 months completed questionnaires whilst attending one of eight mother-and-toddler groups. Using the theory of planned behaviour (Ajzen, 1988, 1991) as its theoretical framework, plus suggested extensions from the literature (i.e. anticipated affect (How displeased or pleased would you be if you gave your baby the following in the next 2 weeks?), moral obligation (I feel obliged to give my baby the following in the next 2 weeks because of their health) and perceived need (To what extent do you feel that you need give your baby the following in the next 2 weeks?)), the questionnaire was developed to assess attitudes and beliefs of mothers regarding eight weaning foods (cheese, chicken, egg, fish, potato, red meat, fruit puree, vegetable puree). The questionnaire also consisted of questions to assess weaning knowledge, behaviour and information sources during weaning.

Multiple regressions of intentions to give different foods, on attitude, subjective norm, perceived behavioural control, perceived difficulty, anticipated affect, moral obligation and perceived need revealed high multiple correlation coefficients (R^2) for the prediction of intention to give a food, suggesting there was a high level of prediction with the variables assessed. Anticipated affect (in the case of 5 of the 8 behaviours) and perceived need (in the case of 6 of the 8 behaviours) are important predictors of intention as reflected by high β-coefficients. The results would argue for the extension of the theory of planned behaviour to include anticipated affect and perceived need.

	Cheese (n 48)	Chicken (n 48)	Egg (n 47)	Fish (n 48)	Fruit puree (n 48)	Meat (n 47)	Potato (n 48)	Vegetable puree (n 48)
Affective attitude (β)	-0.65***	-0.36*	-0.06	-0.37*	0.39*	-0.24	0.25	0.25
Cognitive attitude (β)	0.28*	0.16	-0.02	0.30	0.51**	0.67***	0.31*	0.27
Subjective norm (β)	0.12	0.15	-0.04	-0.24	-0.40**	0.16	-0.01	-0.16
Perceived difficulty (β)	0.40***	0.29**	-0.14	0.39**	-0.10	0.03	0.01	-0.16
Perceived control (β)	-0.07	-0.03	-0.04	-0.13	-0.19*	0.01	-0.01	-0.02
Anticipated affect (β)	0.47***	0.29**	0.48**	0.70***	0.13	0.06	-0.31*	-0.01
Moral obligation (β)	0.20	0.14	0.53**	0.13	-0.18*	0.31**	-0.16	-0.00
Perceived need (β)	0.21*	0.44**	0.21*	-0.04	0.47***	0.05	0.40**	0.45*
R^2	0.86	0.85	0.87	.70	0.84	0.82	0.62	0.38

Significance levels refer to final β-coefficients: *P<0.05; **P<0.01; ***P<0.001.

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Well-being, gastrointestinal function and other reactions to food. By D. BENTON, *Department of Psychology, University of Wales Swansea, Swansea SA2 8PP, Wales*

Although those suffering with chronic constipation score more poorly on measures of well-being (Wald *et al.* 1989; Glia & Lindberg, 1997), the association between constipation in the general population, and their quality of life, has not been considered. A group of 183 apparently healthy young women, aged 20 years and 3 months, answered twelve questions, adapted from Glia & Lindberg (1997), concerning their bodily reactions after eating and described their general mood. The responses were subject to factor analysis using Principal Components Analysis and rotation using the Varimax approach. Four clusters resulted: discomfort (feeling sick, burping), flatulence, constipation and indigestion. Factor scores were calculated. The six dimensions of the bipolar form of the Profile of Mood States questionnaire were used to assess, using a visual analogue scale, how subjects felt generally.

	HOW FREQUENTLY ARE YOU CONSTIPATED?					
	Once a week n 4	Once a fortnight n 10	Once a month n 15	Once every 6 months n 43	Less frequently n 111	
Energetic	25.3 (15.5)	46.7 (28.7)	63.8 (18.7)	57.8 (24.0)	62.7 (24.2)	*
Clearheaded	29.2 (19.8)	44.5 (31.1)	49.0 (17.7)	56.4 (22.9)	60.0 (22.5)	**
Calm	25.2 (15.5)	46.7 (28.7)	63.8 (18.7)	57.8 (24.0)	62.7 (24.5)	**
Confident	36.0 (12.7)	45.0 (29.0)	53.8 (14.8)	51.9 (23.3)	54.7 (21.4)	n.s
Elated	43.2 (27.6)	43.6 (32.7)	51.3 (19.4)	55.3 (20.6)	60.8 (20.1)	*
Agreeable	54.7 (33.4)	58.7 (30.9)	56.7 (21.1)	71.1 (18.5)	73.6 (17.1)	**
Overall mood	203 (54.0)	297 (75.0)	317 (72.0)	334 (81.0)	360 (82.0)	***

Mean values (and the standard deviations) on scale 0–100 or 0–600 for overall mood; $P<0.05$, $**P<0.01$, $***P<0.001$.

The major finding was a consistent tendency for those reporting frequent constipation to report poorer mood. There was a significant inverse association between the factor weighted on the incidence of constipation and reports of generally feeling clearheaded (0.20, $P<0.01$), calm (0.26, $P<0.001$), elated (0.16, $P<0.05$), agreeable (0.25, $P<0.001$) and having a good overall mood (0.29, $P<0.001$). Generally the other factor scores did not predict mood. It was the frequency of constipation, rather than other types of discomfort after eating, that was associated with well-being. The nature of the association is illustrated by the table; in all cases a higher score was associated with a better mood. While a poor mood was associated with frequently suffering with constipation, there was a progressive improvement in mood as its occurrence became less frequent. Although its is to be expected that the discomfort of chronic constipation would depress mood, it was a novel and surprising observation that the association extended throughout the time scale. The correlational nature of the data prevents the conclusion that there is necessarily a causal association, as there are many factors that could influence both mood and the incidence of constipation. There is a need for studies that monitor well-being while manipulating the incidence of constipation.

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Nutrient intake in female gymnasts and healthy age-matched controls: preliminary analysis of a 24-month longitudinal study on bone health. By J.A. NURMI, J.A. BISHOP, D. KOLAGHASSI, H. SIMPSON and S.A. NEW, *Centre for Nutrition and Food Safety, School of Biomedical and Life Sciences, University of Surrey, Guildford GU2 7XH*

Our knowledge of the effect of nutrient intake on peak bone mass (PBM) development in children and adolescents remains unquantified. Research has been focused exclusively on calcium nutrition. Nutrient intake data is often based on weak dietary assessment methods and low subject numbers. Young female athletes are a risk group regarding maximal PBM attainment since high requirements for energy and nutrients due to strenuous training conflict with the likely low food consumption in order to maintain body weight desirable for the sport.

We are currently investigating the potential synergistic effect of diet and weight-bearing physical activity on PBM development in female gymnasts and healthy sedentary controls (total: G *n* 45, C *n* 52). Information on anthropometry, pubertal development, diet and bone mass has been collected at baseline, 6, 12 (Nurmi *et al.* 2000, 2001) and 24 months. Dietary intake has been assessed using repeated estimated dietary records (7 d at baseline, 3 d at 6, 9, 12 and 24 months) and analysed using the Diet 5 version 2000 for Windows program. Data on anthropometry and dietary intake during the first 12 months is presented in the table below.

	Baseline				6 months				12 months			
	G (n 37)		C (n 50)		G (n 31)		C (n 50)		G (n 27)		C (n 44)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age (years)	11.2	2.3	11.2	1.9	11.8	2.3	11.8	2.3	12.2	2.3	12.2	1.9
Height (m)	1.36[a]	0.1	1.48[b]	0.1	1.38[b]*	0.1	1.50[b]*	0.1	1.40*	0.1	1.53[b]*	0.1
Weight (kg)	31[a]	8.4	41[b]	11.1	32[b]*	8.2	43[b]*	11	34*	8.4	46[b]*	11
Energy (MJ/d)	7.1[a]	1.5	7.7[b]	1.2	7.1	1.7	7.7	1.6	7.0	1.1	7.6	1.8
(kJ/kg/d)	243[a]	76	196[b]	51	221[a]	45	184[b]*	44	206**	51	170[b]*	43
EI:BMR	1.51	0.3	1.46	0.2	1.46	0.3	1.44	0.3	1.42	0.2	1.38*	0.3
Fat (g/d)	67	18	74	12	67	18	75	18	68	19	73	21
Ca (mg/d)	703	202	761	185	644	197	738	271	648	208	764	327
Fe (mg/d)	9.4	3.6	10.0	2.7	8.4	2.7	9.2	3.1	8.5	2.6	9.3	3.1

[a,b] Values with unlike superscripts were significantly different (Independent Student's *t*-test), $P<0.05$.
* Significantly different from baseline, $P<0.05$ (Paired samples *t*-test) (*n* G 23, C 43).

Significant increases in height and weight over 12 months in both groups suggest a sufficient level of energy intake (EI). EI per kg body weight was consistently higher in the gymnasts, which reflects the increased energy expenditure through physical activity. However, the increased energy requirement due to growth is not displayed in the EI over 12 months. Values of EI:BMR indicate that some under-reporting exists in the data, but energy requirements of very active children are difficult to assess. Calcium and iron intakes were below the recommendations. A total of 50% and 90% of the gymnasts were below the RNI for calcium and iron, respectively, which is a cause of concern for PBM development. Further analysis of the full 24-month dietary and bone mass data is required to clarify the influence of diet and physical activity on bone health in young females.
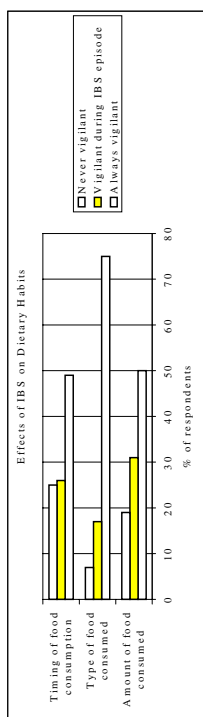
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Gastric emptying of carbohydrate solutions. By C.H. SIMPSON, S.M. SHIRREFFS and J.B. LEIPER, *Biomedical Sciences, University Medical School, Foresterhill, Aberdeen AB25 2ZD*

Prolonged physical activity is associated with the onset of subjective sensations of fatigue and a reduced exercise capacity. The causes of fatigue have been the subject of extensive investigation, and are generally considered to be one of two different factors (Maughan, 1991). The first is a reduced availability of metabolic substrate, especially muscle glycogen and blood glucose. The second is a reduction in body water as a consequence of inadequate replacement of sweat losses. Drinking strategies to provide both fluid and carbohydrate (CHO) substrate during exercise are effective in delaying the onset of fatigue and improving exercise performance (Below *et al.* 1995). Gastric emptying of fluid is slowed with an increase in CHO content and to a lesser extent, osmolality (Vist & Maughan, 1995), but the sports drink formulation that gives the fastest delivery of both water and CHO to the absorptive surface of the small intestine is still a matter of debate.

The current study compares the gastric emptying (GE) rates of three CHO drinks (6.4% isotonic (6-Iso; 283 (SD 4) mosmol kg^{-1}), 6.4% hypotonic (6-Hypo; 118 (SD 1) mosmol kg^{-1}), 2% hypotonic (2-Hypo; 85 (SD 2) mosmol kg^{-1})) with water (W; 8 (SD 2) mosmol kg^{-1}).

Following Ethics Committee approval, ten healthy male volunteers (mean age 24 (SD 6) years, height 183 (SD 8) cm, body mass 79.1 (SD 11.5) kg) were recruited into the study. Subjects were familiarized with the study protocol before undertaking four experimental trials. On each experimental trial GE was measured for 60 min using a gastric aspiration technique with subjects at seated rest (Beckers *et al.* 1988). Trial order was randomized and trials were separated by at least 7 d. All trials commenced after a fast of at least 6 h and on each occasion 500 ml of the test drink at 18.6 (SD 1.8) ° was infused into the stomach. Statistical significance ($P<0.05$) was determined using Kruskal-Wallis and Mann Whitney tests where appropriate.

T½ (min)	Median	Range
6-Iso	17.1	9.8–28.4
6-Hypo	13.4	9.1–30.6
2-Hypo	8.9	6.4–25.6
W	6.9	4.6–12.5
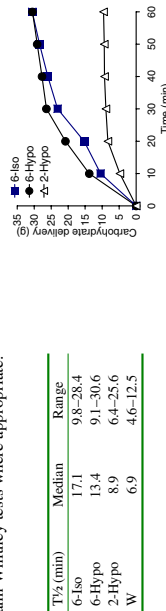
The half emptying times (T½, see table) of the 6.4% CHO drinks were similar (P 0.520) and both were slower than 2-Hypo ($P<0.026$) and W (P 0.001). The T½ of 2-Hypo and W were similar (P 0.120). There was no difference in the calculated cumulative CHO delivery to the small intestine from the two 6.4% CHO drinks (see figure), although there was an indication that this tended to be delayed with the isotonic drink in comparison with the hypotonic drink 20 min after infusion (P 0.090). However, 2-Hypo always delivered less CHO than the two 6.4% drinks ($P<0.011$).

These results indicate that, in comparison with plain water ingestion, water delivery to the small intestine is not compromised when a 2% CHO hypotonic drink is consumed. This provides the opportunity to supply the intestine with CHO for absorption whilst maintaining water delivery. When substrate delivery is of prime importance a 6.4% CHO drink is more effective than the 2% CHO drink, regardless of whether it is isotonic (283 mosmol kg^{-1}) or hypotonic (118 mosmol kg^{-1}).

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Irritable bowel syndrome and dietary habits in a selected group of sufferers. By H. KILLALA and C. SHORTT, *Yakult UK Ltd, 12–16 Telford Way, Westway Estate, London W3 7XS*

Irritable bowel syndrome (IBS) is a common functional gastrointestinal (GI) disorder; typical symptoms include altered bowel habits accompanied by abdominal pain or discomfort. The aetiology is poorly understood and no biochemical or structural abnormalities have been identified (Shaw *et al.* 1998). Research has identified disturbances in the normal gut flora of individuals with IBS and probiotic administration has been suggested to restore the microflora balance and alleviate GI symptoms (Friedman, 2000; Nobaek *et al.* 2000). This study examines the extent to which specific foods affect individuals diagnosed with IBS and the impact of IBS on dietary habits.

A postal questionnaire, which assessed the dietary habits of IBS sufferers and the effect of diet on symptoms, was sent together with a reply-paid envelope to 1000 members of the UK-based IBS Network in January 2001. Of the 714 questionnaires returned (response rate, 71%), only those from individuals diagnosed with IBS (n 678) were included in the final analysis.

Effects of IBS on Dietary Habits

Approximately half of the respondents were vigilant all of the time about the amount and timing of food intake, and up to a further 31% were vigilant during episodes of IBS. In addition, some 75% of the respondents were careful about the type of food they ate all of the time and a further 17% were particularly cautious during an IBS episode. The results indicated that specific foods were perceived by the respondents to affect their IBS symptoms. Most notably, spicy foods were identified as triggering and exacerbating symptoms in 43% and 34% of the respondents, respectively. Breads and cereals, dairy products, fruit and fruit juices and vegetables were reported to trigger or exacerbate symptoms in 21–28% of the respondents. Few indicated that specific foods alleviated their symptoms. However, 32% (n 141) of those that consumed live yoghurts or fermented milk drinks (probiotics) reported that they relieved their IBS symptoms. Furthermore, 14% (n 64) indicated that these foods prevented their symptoms.

Results suggest that IBS affects the dietary habits of individuals to a considerable degree and that specific foods appear to have a direct impact on IBS symptoms. In particular, some IBS sufferers appear to find probiotic-type products beneficial. It is plausible that an imbalance of the gut flora may give rise to altered peristalsis and gut secretions. These effects may in turn lead to specific IBS symptoms, and restoration of the microflora balance may alleviate these symptoms (Famularo *et al.* 1999; Hunter *et al.* 1999; Faber & City, 2000). More detailed studies investigating the role of dietary gut flora modulation and the identification of dietary trigger or exacerbating factors in IBS are warranted.

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In vitro fermentation of pyrodextrinized lentil and cocoyam starches. By A. LAURENTIN and C.A. EDWARDS. *Department of Human Nutrition, University of Glasgow, Yorkhill NHS Trust, Glasgow G3 8SJ*

Starch modification techniques have been developed for industrial processing in the last few decades to produce a wide range of potential food ingredients. However, interest in modified starches has been restricted mainly to the technological aspects with little concern about the possible impact of the modification on the starch bioavailability and fermentability (Tovar et al. 1999). The aim of this work was to investigate the effect of pyrodextrinization (a starch modification carried out by heat treatment, 140° for 3 h, with catalytic amounts of HCl, 1.82g/kg starch) on the net SCFA production and individual molar ratios, using lentil (*Lens esculenta*) or cocoyam (*Xanthosoma sagittifolium*) starches as a substrate in a simple *in vitro* model of the human colon.

After pyrodextrinization, the starch products were pre-digested with pepsin and pancreatic enzymes using a modified Englyst method (Englyst et al. 1992) and the digestible components were removed by dialysis. The resistant starch component was then tested for its fermentation characteristics. Individual faecal samples from (6–7) healthy adults (32–36 years, 1 female) were processed within 2 h of passage. A 16% faecal slurry was anaerobically incubated in phosphate buffer (pH 6.5) with 100 mg of raw or modified starch in MacCartney bottles in a shaking water bath (50 strokes/min) at 37° for 24 h (Edwards et al. 1996). Cultures were analysed for SCFA, pH and residual starch.

| | Lentil | | | | Cocoyam | | | |
| | Raw | | Modified | | Raw | | Modified | |
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Net total SCFA (mmol/l)	58.5	1.8	56.2	1.8	60.1	7.3	59.2	2.3
Individual SCFA molar ratio								
Acetate	657	52	513[**]	13	660	35	511[*]	14
Propionate	154	35	259[*]	29	111	9	261[**]	28
n-Butyrate	147	27	150	17	161	15	154	17
iC4-C8	42	12	77	13	69	24	75	15
Fall in pH, from 6.4 (0.1)	1.5	0.1	0.9[***]	0.04	1.4	0.1	1.0	0.04

[*]$P<0.05$, [**]$P<0.01$ and [***]$P<0.001$ compared with raw starch (two sample t-test).
iC4-C8 represents the sum of iso-butyrate, iso-valerate, valerate, hexanoate, heptanoate and octanoate.

There was a similar and almost complete fermentation of both materials, based on net total SCFA and residual starch (less than 2%) amounts. However, the modified samples showed a significant increase in the molar ratio of propionate with a parallel decrease in acetate. There was no change in the *n*-butyrate molar proportion. This may be the result of the new glycosidic bonds produced during pyrodextrinization which may be cleaved by different bacteria. This change may have nutritional implications as it has been shown that a decrease in acetate with increased propionate utilization in the liver may act together to decrease lipogenesis (Wolever et al. 1996).

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Development and validation of a chart for measuring stool output in patients receiving enteral tube feeds. By K. WHELAN[1], P.A. JUDD[1] and M.A. TAYLOR[2]. [1]*Department of Nutrition and Dietetics, King's College London, Franklin Wilkins Building, 150 Stamford Street, London SE1 9NN and* [2]*School of Biomedical Sciences, University of Nottingham, E Floor Medical School, Nottingham NG7 2UH*

Diarrhoea is a common side-effect of enteral feeding. The reported incidence is dependent upon how diarrhoea is defined (Bliss et al. 1992). Definitions usually incorporate the criteria of stool frequency, consistency and quantity. Whilst stool frequency is easy to record, the measurement of stool consistency and quantity is impractical in the clinical setting. Consequently, the recording of these variables relies upon estimation by nursing staff, which is subjective and unreliable.

A stool chart was developed incorporating twelve different photographs of stool models, labelled with a code letters A to L. Each photograph corresponded to one of three different quantities (<100 g, 100–200 g, >200 g) and one of four different consistencies (hard & formed, soft & formed, loose & unformed, liquid). The models were made using pre-determined quantities of dried mashed potato, food dye and boiling water to achieve the appropriate consistency and quantity. The aim of this study was to measure the validity (content, concurrent) and reliability (inter-rater) of the chart in measuring stool output in patients receiving enteral tube feeds.

Content validity was measured by a postal questionnaire survey of health professionals involved in enteral tube feeding. In a clinical study, patients receiving polymeric enteral tube feeds were prospectively recruited from St. George's Hospital, London. Each time a patient defecated, the nursing staff were asked to record the code from the chart that most closely corresponded to the actual stool. The researcher attended the ward once daily to weigh each patient's stool and to independently ask two nurses to assign a code to the stool using the chart and to assess whether they thought the patient had diarrhoea or not. Concurrent validity was measured by comparing the weight given by the code on the chart (<100 g, 100–200 g, >200 g) with the actual weight of the stool. Inter-rater reliability was measured by comparing the independent responses of the nursing staff.

Thirty-five health professionals responded to the questionnaire survey including dietitians (n 35), specialist stroke nurses (n 7), critical care nurses (n 9) and consultant gastroenterologists (n 11). Those surveyed indicated that the most important criteria for defining diarrhoea was stool frequency followed by consistency and quantity, respectively. In the clinical study, data were collected on thirty-six enterally tube-fed patients, during which time fifty-nine stools were weighed. Results for concurrent validity and inter-rater reliability are shown below.

	%	κ coefficient	Strength of agreement (Landis & Koch, 1977)
Concurrent validity (n 118)			
Stools assigned to the correct quantity	83	0.75	Substantial
Inter-rater reliability (n 59)			
Nursing staff agreeing on:			
quantity	83	0.75	Substantial
consistency	95	0.91	Almost perfect
quantity and consistency	80	0.78	Substantial
presence of diarrhoea	75	0.48	Fair

The results of the questionnaire suggest that the chart incorporates useful variables relating to the measurement of stool output in patients receiving enteral tube feeds. Results from the clinical study suggest that the chart encourages accurate assessment of approximate stool weight from visualization alone. The chart also allows reliable recording of both stool quantity and stool consistency. Furthermore, the reliability of nurses' perception of the presence of diarrhoea is only fair. The chart is a valid, reliable and practical tool for measuring stool output in patients receiving enteral tube feeds and is suitable for both clinical and research use.

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Folic acid supplementation and intestinal tumorigenesis in the Min (Apc +/–) mouse. By R.I. VALENTINE, G.J. CUSKELLY and J.C. MATHERS, *Human Nutrition Research Centre, Department of Biological and Nutritional Sciences, University of Newcastle upon Tyne, Kings Road, Newcastle upon Tyne NE1 7RU*

Colorectal cancer (CRC) is the third most common cancer in developed countries and the second most common cause of malignant death in England and Wales. Epidemiological evidence suggests a strong inverse association between CRC morbidity and mortality and intakes of folic acid (Glynn & Albanes, 1994). Moreover, there is plausible evidence that folic acid may protect against carcinogenesis through its effects on methylation, synthesis and repair of DNA (Blount & Ames, 1995).

The Min (Apc +/–) mouse (a model with a nonsense mutation at codon 850 in the *Apc* gene that exhibits phenotypic characteristics similar to those in human Familial Adenomatous Polyposis; FAP) has been used extensively to investigate the effects of drugs and diet on intestinal tumorigenesis (Shoemaker *et al.* 1997). At weaning, Min mice (*n* 26) were randomized to one of two diets, which differed only in their folic acid concentration, i.e. 2 and 34 mg/kg diet, respectively. All animals were killed at the end of the 12-week intervention period. Number, size and location of adenomas in both small intestine (SI) and colon were recorded. Tumour burden was calculated as the sum of tumour diameters.

As expected, most adenomas were found in the SI and this distribution was not affected by treatment. Tumour number and burden in both SI and colon were higher in mice consuming the higher dose of folic acid, although the differences were not statistically significant (SI tumours, *P* 0.229; SI burden, *P* 0.165; Colon tumours, *P* 0.104; Colon burden, *P* 0.080).

| | | Tumour number | | | | Tumour burden (mm) | | | |
| | | Small intestine | | Colon | | Small intestine | | Colon | |
	n	Mean	SE	Mean	SE	Mean	SE	Mean	SE
2 mg folic acid/kg	9	10.1	2.97	0.11	0.11	18.4	4.33	0.71	0.27
34 mg folic acid/kg	17	17.4	4.52	0.22	0.22	29.2	4.76	2.21	0.8

Our results suggest that supraphysiological doses of folic acid (17× basal requirement) enhance intestinal tumorigenesis in this animal model. These results are consistent with those of Kim *et al.* (1996) in the dimethylhydrazine rat model of CRC.

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The effects of butyric acid upon rat lymphocytes: proliferation, cytokine production and expression of membrane proteins. By M.G. VECCHIA[1], C.R. CAVAGLIERI FELIPE[1], A. NISHIYAMA[2], L.C. FERNANDES[2], R. CURI[1] and P.C. CALDER[3], *[1]Department of Biophysics and Physiology, University of São Paulo, Brazil, [2]Department of Physiology, University of Paraná, Brazil and [3]Institute of Human Nutrition, University of Southampton, Southampton SO16 7PX*

Previous studies have shown that fibre-rich diets decrease tumour cell growth (Clausen, 1991; McIntyre *et al.* 1993). This effect is modulated by the formation of short-chain fatty acids (SCFA) such as acetic, propionic and butyric acid formed by the fermentation of water-soluble fibre by anaerobic bacteria present in the large bowel. Butyrate inhibited tumour cell proliferation and was the most effective inhibitor when compared to acetate and propionate (Vecchia *et al.* 1992). It is possible that fibre-rich diets also decrease tumour cell growth by a mechanism involving the immune system. Therefore we investigated the effect of butyric acid upon lymph node and spleen lymphocytes *in vitro*. In this work we compared the effect of butyrate to that of acetate and propionate on lymph node lymphocyte proliferation and cytokine production. In spleen lymphocytes, we investigated the effect of butyrate upon the expression of membrane protein (T cell receptor (TCR), CD8, CD4).

Spleen and lymph node lymphocytes were obtained from male Wistar rats (Yaqoob & Calder, 1997) and stimulated with concanavalin A (Con-A). Lymphocyte proliferation was determined as radioactive thymidine incorporation and cytokines produced after 24 h of culture were measured by Cytoscreen ELISA kits. Flow cytometric analyses were used to determine TCR, CD8, and CD4 expression in lymphocytes.

Butyric acid (1 mmol/l) inhibited the proliferation of Con-A-stimulated lymphocytes by 96.3 (0.8)%. Acetate and propionate, either alone or together, did not change this parameter. However, the presence of butyric acid in combination with acetate or propionate, or both, inhibited proliferation by 97.6 (0.4), 96.7 (0.2), and 97.0 (0.4)%, respectively. Butyric acid also reduced interleukin (IL)-2, IL-10 and interferon (IFN)γ production. In spleen lymphocytes, butyrate reduced TCR expression by about ten-fold when compared with control. CD4 and CD8 expression did not change significantly.

Con-A binds to the TCR/CD3 complex, activating lymphocytes largely via phospholipase-C-mediated events. Although many aspects of this activation are unclear, the TCR binding triggers responses such as cytokine production and results in cell proliferation. The mechanisms by which butyric acid exerts its effects are unknown. However, we consider the possibility of a reduction in cytokine production such as IL-2, or cell death. Indeed, IL-2 production was reduced as well as that of IL-10 and IFNγ. The analysis of protein expression by flow cytometry shows that CD4 and CD8 did not change in the same experimental conditions, which indicates maintenance of cell viability. On the other hand, expression of TCR was markedly reduced and this suggests that Con-A could not activate the cell and, as a consequence, proliferation would be inhibited.

Our findings indicate that the modulation of T-cell responses by butyric acid results in a decreased rate of proliferation, accompanied by reductions in IL-2, IL-10 and IFNγ secretion and TCR expression. It is possible that the modulation of T-cell responses by butyrate may be via the TCR and this could result in decreased IL-2 production and the inhibition of thymidine incorporation. Thus, it appears that butyrate causes many effects which could result in a suppressed T-lymphocyte response.

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Intragastric macronutrient infusion effects upon food intake and rated appetite. By T.M. ROBINSON[1], R. ALAM[1], M.R. YEOMANS[2] and S.J. FRENCH[1]. [1]Centre for Human Nutrition, University of Sheffield, Northern General Hospital, Herries Road, Sheffield S5 7AU and [2]Experimental Psychology, Sussex University, Brighton BN1 9QG

The macronutrient content of the diet has a crucial influence on an individual's energy balance. Overeating and obesity are associated with high-fat diets, often due to their palatability and high energy density. Intragastric preloads can be used to remove the influence of palatability, allowing specific nutrient effects to be investigated. The aim of the present study was to examine the effects of different macronutrient infusions on subsequent food intake and subjective appetite.

On separate days, seven healthy volunteers (five females) received 300 ml intragastric infusions of a low-energy control soup (LE, 60 kcal; 251 kJ), two high-energy soups (high carbohydrate, HC; high fat, HF; both 360 kcal; 1506 kJ) or a volume control (VC, distilled water) in randomized order. After 30 min following infusion, subjects ate a test meal to voluntary fullness. Subjects also reported their appetite ratings and recorded food intake for the remainder of the day.

Fig 1

Food intake

a, $p < 0.05$ vs. VC
b, $p < 0.01$ vs. VC
c, $p < 0.01$ vs. LE

Preload type
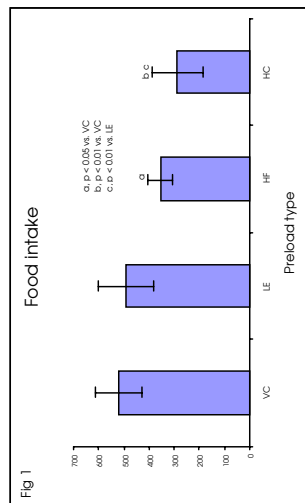
Both high-energy preloads reduced test-meal intake ($P<0.01$), with HC producing the greatest reduction (Fig 1). No significant difference was observed in intake between the HF and HC treatments.

Hunger and fullness were unchanged by treatments prior to meal consumption. Hunger was lower than controls at 1 h following the test meal (HF, HC; $P<0.05$). Fullness was greater than controls at 1 h (HC only, $P<0.01$) and 2 h (HF, HC; $P<0.05$) following the test meal. Fullness was greater at 1 h for HC than HF ($P<0.05$). No differences existed in overall energy intake during the test day, suggesting that subjects adequately compensated for the high-energy preloads. These data confirm previously observed short-term effects of direct gastrointestinal infusions due to their energy content. However, in the absence of oro-sensory cues, no differential effects of macronutrient type could be distinguished.

Effect of administration of prolactin throughout rat pregnancy on brown adipose tissue development. By H. BUDGE[1], A. MOSTYN[1], V. WILSON[1], A.M. WALKER[2], M.E. SYMONDS[1] and T. STEPHENSON[1]. [1]Academic Division of Child Health, University of Nottingham, Nottingham NG7 2UH and [2]Division of Biomedical Sciences, University of California, USA

Uncoupling protein-1 (UCP1) is unique to brown adipose tissue and effects the production of heat after birth in non-shivering thermogenesis. In lambs with mature hypothalamic-pituitary axes at birth, BAT maturation occurs over the final half of gestation. During fetal development, mRNA expression of receptors to the hormone prolactin (PRL) appears at the gestational age at which UCP1 is initially detected (Symonds et al. 1998). UCP1 and PRL receptors both reach maximum abundance soon after birth and, thereafter, during early postnatal life, changes in UCP1 abundance are associated with parallel changes in PRL receptor abundance (Budge et al. 2001). In addition, PRL administration in the first 2 d of life is associated with improved thermogenesis with maintenance of newborn temperature (Pearce et al. 2000). The present study was designed to determine whether UCP1 abundance can be altered by maternal PRL administration during fetal development in a species which has an immature hypothalamic-pituitary axis at birth, i.e. rats.

Eight female Sprague-Dawley rats were randomly allocated to control (no PRL; n 4) or treatment with recombinant prolactin continuously administered by minipump from 12 h after mating at 6 mcg/d to achieve plasma prolactin concentrations of 50 ng/ml by day 4 of pregnancy until delivery at term (day 20; n 4). Rat pups delivered spontaneously and, at 18 h of age, were euthanased by overdose of metafane and intrascapular BAT was collected. The abundance of UCP1 was determined by immunoblotting as described by Budge et al. (2000) and is expressed relative to a reference sample. In addition, one pup from each litter was randomly selected and immunohistochemistry for UCP1 was performed on histological sections of BAT.

Maternal administration of PRL had no effect on the in utero or post-delivery pup survival, duration of pregnancy or pup weight. Maternal PRL infusion resulted in a two-fold increase in UCP1 abundance in the BAT of offspring (C: 3.13; PRL: 7.21% reference) and this BAT had a much darker visual appearance. On histological inspection, PRL infusion resulted in BAT cells with reduced numbers of lipid droplets when compared to controls and increased abundance of UCP1 as assessed by immunohistochemical staining.

In conclusion, maternal infusion of PRL throughout fetal development in rats results in increased UCP1 abundance in intrascapular BAT at 18 h of postnatal age. As lipid content was concomitantly reduced by maternal PRL infusion, this is likely to reflect BAT that is metabolically active. These observations further implicate prolactin in the regulation of fetal and neonatal BAT maturation and function.

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Factors influencing body composition measurement using air displacement plethysmography: is body surface area an issue? By A.L. COLLINS and H.D. McCARTHY, *Nutrition Research Unit, School of Health and Sports Science, University of North London, 166–220 Holloway Road, London N7 8DB*

Measurement of human volume by air displacement plethysmography (ADP), used in the BodPod measurement system, relies upon a correction for body surface area incorporated into a surface area artifact. Body surface area estimation usually relies on the initial studies of DuBois & DuBois over 80 years ago (DuBois & DuBois, 1916), but alternative predictive equations have also been put forward (Gehan & George, 1970; Haycock *et al.* 1978; Shuter & Aslani, 2000). In this analysis, body volume, and hence body density, were calculated encompassing these four predictive equations in a sample of sixty-one subjects (27M, 34F), ranging in BMI from 17.9 to 55.0, who had body composition measured by the BodPod. The impact of surface area artifacts on derived percentage body fat was then ascertained. In addition, in a subset of fourteen subjects, body composition was assessed by the total body water method (TBW), via deuterium dilution, measured in saliva by Fourier transform infra-red spectroscopy (FTIR).

There was no significant difference between percentage body fat derived from ADP in comparison with TBW, as an independent measure of body composition in our subset. However, there was a significant correlation between magnitude of difference between the two methods and percentage body fat (*P* 0.034). This suggests a greater underestimation by the BodPod at lower levels of body fat. When comparing mean measurement differences for men and women between the two methods, there appears to be a gender issue, as the BodPod underestimated percentage body fat to a greater extent in men than in women. This is in agreement with other studies, which have demonstrated this difference in comparison with underwater weighing (Levenhagen *et al.* 1999). This apparent discrepancy may suggest that perhaps anatomical differences in body surface at difference body fat levels could be contributing to errors in BodPod measurements.

Body surface area was strongly correlated to FFM for all predictive equations (r^2 0.8516) as demonstrated elsewhere (Kral *et al.* 1998). This may suggest a possible explanation for gender differences across a range of body fat, considering that men tend to have a higher FFM than women of the same body weight and height. On investigation of potential surface area variability, it was found that there was no significant difference between body fat values obtained from the BodPod (which uses the original Dubois formula) and values using either Gehan & George (1970) or Haycock *et al.* (1978). On using the newly corrected formula of Shuter & Aslani (2000), body fat values were significantly *lower* than those obtained from the BodPod (*P*<0.001). However, this mean difference was only of the magnitude of 0.1% body fat. On stratifying the data for gender, this difference remained significantly lower (*P*<0.001), and the magnitude of mean difference continued to be of the order of 0.1% for both males and females. Further analysis demonstrated that the difference between BodPod values and each of the three alternative methods were significantly, and negatively, correlated to both body fat and fat mass (*P*<0.05), whereby level of agreement decreased with increasing body fat. This significant negative relationship was particularly strong in females (r^2 –0.7; males, r^2 –0.3).

Nevertheless, this impact of surface area, when compared with percentage body fat derived from TBW in our subset, did not correct for previously mentioned discrepancies between methods. It can be concluded that the potential discrepancies in body composition assessment by ADP cannot be fully explained by issues of body surface area estimation alone, as the magnitude of difference shown is very small and in the opposite direction. Other possible influences on ADP measurement could be gender differences with regard to clothing and body hair, and perhaps compressibility of subcutaneous fat. However, in light of this study on surface area, gender differences and the impact of body fat itself on actual measured surface area would be worth pursuing further in this context, but this requires better methods for body surface area measurement.

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Effect of date of mating and housing on lamb growth, thermoregulation and adipose tissue deposition. By S. PEARCE[1], A. MOSTYN[1], E. GENEVER[1], R. WEBB[2], M.E. SYMONDS[1] and T. STEPHENSON[1], [1]*Academic Division of Child Health, School of Human Development, University Hospital and [2]Division of Agriculture and Horticulture, School of Biological Sciences, University of Nottingham, Nottingham NG7 2UH*

In lambs, the rapid increase in heat production after birth is due to the initiation of nonshivering thermogenesis in brown adipose tissue (BAT). This occurs in conjunction with an increase in amount and activity of BAT specific uncoupling protein-1 (UCP-1; Clarke *et al.* 1997). UCP-1 abundance is low in fetal life but, within 12 h of birth, there is an increase in the thermogenic activity of BAT and mRNA for UCP-1. Lambs born in the autumn are known to be smaller than those born in the spring (McCoard *et al.* 1997). It is not known whether moderate changes in date of mating can influence birth weight or thermoregulation. The present study aimed to determine whether date of mating could influence lamb birth weight, the abundance of BAT, UCP-1 or colonic temperature.

Thirteen triplet-bearing ewes were divided into two groups according to their date of mating (Group 2 conceived 2 weeks, i.e. one cycle, after Group 1). All ewes were group housed from 56 (Group 2) and 77 (Group 1) d gestation and offered straw *ad libitum* and a fixed amount of concentrate. After lambing, the ewes and their lambs were individually housed. One randomly selected lamb from each set of triplets was inserted into the study and jugular venous catheters were inserted to allow daily blood sampling. For the following 7 d, the lambs were weighed and colonic temperature measured prior to blood sampling. On day 7, perirenal adipose tissue was sampled from all lambs following euthanasia. Abundance of UCP-1 was determined by immunoblotting and values are expressed as a percentage of a reference sample included on all gels. Results were analysed by Mann-Whitney *U*-test and are presented as means and standard errors (SEM).

Group	Lamb birth weight (kg)		Crown rump length (cm)		Weight of PAT on Day 7 (g)		Colonic temperature on Day 1 (°C)		Abundance of UCP-1 (% of reference)	
	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
Group 1	3.96	0.18[a]	43.9	0.55[a]	22.2	2.44[a]	39.5	0.20	81.9	8.69[a]
Group 2	5.18	0.19	46.7	0.96	37.5	5.43	39.9	0.19	58.0	6.91

[a] Significant difference between the two groups at *P*<0.05 level, as measured by Mann-Whitney *U*-test.

The lambs born 2 weeks earlier in the season were smaller, shorter, with a significantly slower growth rate than the lambs born 2 weeks later in the season (Group 1, 167 g/d; Group 2, 254 g/d (*P*<0.05). Group 1 also had less adipose tissue but a greater abundance of UCP-1 on day 7 despite a non-significantly lower colonic temperature on the first day of life. Average, minimum and maximum environmental temperature did not differ significantly during the study.

In view of previous studies, these variations are unlikely to be the result of differences of date of indoor housing or altered nutritional intake because, for example, restriction of maternal nutrition by 50% in early to mid-gestation has no effect on fetal weight at term (Heasman *et al.* 1998). Differences between the two groups of lambs may be accounted for by the date at which the ewes were mated, as the mothers of the second group of lambs had a greater number of cycles before conception. However, the extent to which small differences in time of mating can alter placental and fetal development remains to be elucidated.

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Knowledge of osteoporosis and prevalence of dietary and lifestyle risk factors for poor bone health in 16–18 year-old males and females. By C. JAGGERS[1], S. WISDEN[1], J. CATTERICK[1], I.A. BISHOP[1], D.J. PATTISON[2], A.D. WOOLF[2] and S.A. NEW[1], [1]Centre for Nutrition and Food Safety, School of Biomedical and Life Sciences, University of Surrey, Guildford GU2 7XH and [2]Duke of Cornwall Rheumatology Unit, Royal Cornwall Hospital, Truro, Cornwall TR1 3LJ

Current research suggests that dietary quality and lifestyle habits amongst the younger population are a cause for concern (Gregory et al. 2000). These findings have important implications for skeletal health, since the amount of bone gained in early life may determine those who develop osteoporosis in later life. Interestingly, there are few studies examining the knowledge of bone health in relation to risk factors for osteoporosis amongst teenagers. As part of an investigation into the extent of osteoporosis in young British women (Catterick et al. 2001), a study to determine the dietary and lifestyle habits of males and females aged 16–18 years and knowledge of osteoporosis is under way. A total of 500 subjects from schools are being targeted and asked to complete a purpose-designed questionnaire. Preliminary data are presented on 295 subjects (35% male, 65% female).

Physical activity levels were found to be low, with over two-thirds of subjects failing to meet the Health Education Authority's recommendations. Mean alcohol consumption was 7.4 measures/week, despite most subjects being below the legal drinking age of 18 years. Spirits and lager/beer were the most popular drinks in male subjects compared to wine and spirits in female subjects Although the proportion of individuals who admitted to smoking was similar amongst males and females (34% and 33%, respectively), the number of cigarettes smoked was greater in male subjects, as was alcohol consumption.

Breakfast 'skipping' amongst subjects was frequent, with a third of all males and females stating that they regularly missed breakfast. Milk and dairy product consumption was found to be inadequate, with one in ten females consuming no milk at all and very little intake by way of dairy products. Only 20% of subjects ate five pieces of fresh fruit every day, with 'unavailability at school' being stipulated as the main reason for not consuming fruit on a regular basis. Perceptions of body weight were poor, with 70% of females expressing a desire to weigh less and almost 50% of females admitting to currently trying to lose weight.

Knowledge of osteoporosis in terms of definition, causes and occurrence in subjects was basic. A large proportion had some knowledge of poor bone health but only 50% knew of the major risk factors for the disease. Only 12% of subjects knew the correct prevalence of osteoporosis in women (i.e. one in three women over 55 years) and only 20% estimated correctly the financial costs of osteoporosis to the NHS (i.e. £1.8 billion). Knowledge of the beneficial and detrimental risk factors for bone health was generally good, with the majority of subjects considering milk to be 'healthy' for bones and smoking to be 'unhealthy'. Exercise was considered important but there was no differentiation between weight-bearing and non-weight-bearing activities.

Further analysis of the study population is required. However, since increasing bone mass early in life is considered the most effective approach for the prevention of osteoporosis, these preliminary data provide evidence that an education resource pack aimed specifically at older teenagers is warranted.

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Bone mineral density and body mass index of patients with ileostomies. By D.H.L. NG, A.N.J. MAY, S.A. WOOTTON and M.A. STROUD, Institute of Human Nutrition, University of Southampton, Southampton General Hospital, Tremona Road, Southampton SO16 6YD

Many patients with ileostomies are presumed to be healthy following surgery and are discharged from specialist care. A history of inflammatory bowel disease with steroid use is common in these patients and the loss of normal function of the colon may also have detrimental metabolic and nutritional consequences. Some patients with a colectomy also have an additional small bowel resection that may also affect nutrient absorption. There is little information in the literature characterizing the bone health and nutritional status of these patients. We undertook a cross-sectional study examining the bone mineral density (BMD) and body mass index (BMI) of a cohort of ileostomy patients with and without small bowel resection.

A cohort of thirty-eight patients aged 26 to 85 years (15F; 23M) with a total colectomy and permanent ileostomy for more than 12 months were recruited. Of these, twelve patients (6F; 6M) had a small bowel resection. None of these patients were on steroids at the time of study. Their weight and height were measured and BMI was calculated. Dual energy X-ray absorptiometry scans of their lumbar spine and right femoral neck were carried out to determine BMD. Results of the BMD for patients with and without small bowel resection were expressed relative to standardized reference values (Kelly et al. 1990; Looker et al. 1995) and the age-adjusted Z scores are given in the table.

	BMI (kg/m²)		Lumbar spine Z score		Femoral neck Z score	
	Mean	SD	Mean	SD	Mean	SD
No small bowel resection	26.63	6.08	0.405	1.533	0.392	1.105
Small bowel resection	23.99	4.66	−0.455	0.825 *	−0.445	0.868 *

* Values significantly different from those patients without small bowel resection (P<0.05).

Taken as a group, this cohort of patients do not appear to have Z score values indicative of a profound bone demineralization. However, within this cohort, the mean lumbar spine and femoral neck Z score of patients with small bowel resection were significantly lower than those of patients with intact small bowel (both P<0.05). Proportionately more Z scores <–1.0 were observed in those patients with small resection than those with intact small bowel (7 of 12 v. 7 of 26, respectively; P<0.05). Although there was no significant difference in BMI between groups, there was a relationship between BMI and BMD (r 0.549; P<0.001) consistent with that reported in previous studies indicating that BMI is a predictor for BMD (Lunt et al. 1998; Stroud et al. 2001). These results suggest that total colectomy alone does not increase the risk of BMD reduction; however, this risk may be increased by additional small bowel resection.

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Influence of maternal nutrition during early to mid-gestation on blood pressure control of juvenile offspring in sheep. By G. GOPALAKRISHNAN[1], S. PEARCE[1], J. DANDREA[1], A. MOSTYN[1], R.M. WALKER[1], M.M. RAMSEY[1], T. STEPHENSON[1] and M.E. SYMONDS[1], School of Human Development and [2]School of Biosciences, University of Nottingham, Nottingham NG7 2UH

Epidemiological and experimental studies have indicated that maternal undernutrition at specific stages of pregnancy is associated with abnormal placental and fetal growth. Consequently, vascular structure and physiology of the resulting offspring may be altered. Maternal nutrient restriction over the period of rapid placental growth (i.e. 30–80 d), followed by adequate nutrition up to term, results in a longer fetus with a disproportionately larger placenta (Heasman et al. 1998). These individuals may be at increased risk of adult diseases including hypertension (Barker, 1995). The aim of this study was to determine the consequences on blood pressure control in offspring born to nutrient restricted (NR) ewes born early to mid-gestation.

Fourteen Welsh Mountain ewes of similar body weight and fat distribution were individually housed from 28 d gestation. Seven ewes were NR, these consumed 3.5 MJ of metabolizable energy (ME) per day (≡ 60% of ME requirements for maintenance and growth of the conceptus) until 80 d gestation, with seven controls (C) consuming 6.8–7.5 MJ/d. After 80 d gestation, until term (147 d), all animals consumed 6.8–7.5 MJ/d, sufficient to fully meet their ME requirements. Lambs were delivered spontaneously and each ewe raised a single lamb that was weaned at 6 weeks of age. At 6 months of age, a caroid artery and jugular vein were surgically catheterized to allow measurement of blood pressure and drug administration. Surgery lasted under an hour for all lambs, but one lamb, offspring of a NR ewe, did not survive surgery. At least 2 d after surgery, mean, systolic and diastolic blood pressure were measured for a resting period of 30 min, before a continuous infusion of noradrenaline with dose increases (0.5–32 ng/kg per min) at 10-min intervals.

Results are expressed as mean values and standard errors. Statistically significant differences between groups were assessed using a Mann-Whitney test.

Maternal group	Lamb birth weight (kg)		Lamb growth rate (g/day)		Resting mean blood pressure (mmHg)		Resting diastolic blood pressure (mmHg)		Peak diastolic blood pressure (mmHg)	
	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
NR (n 6)	4.68	0.15[a]	149	9.7	56.2	2.7[a]	46.3	2.6	88.3	6.0
Control (n 7)	3.49	0.33	167	6.1	63.9	1.6	52.8	2.1	82.4	3.4

[a] Significantly different from control at P<0.05 level, as measured by Mann-Whitney U test.

Lambs born to NR ewes were heavier than those born to controls. There was no difference in growth rate up to 6 months. There was no difference in resting systolic and mean blood pressure were lower in lambs born to NR ewes (P<0.05). There was no statistical difference between groups for peak blood pressure at the maximal dose of noradrenaline. The rise in systolic and diastolic pressures between resting and peak recordings was less in the control lambs. In particular, lambs born to NR ewes showed a trend towards a greater increase in diastolic pressure compared with control lambs (NR mean 45.3, SEM 4.8; C mean 32.0, SEM 2.0 mmHg (P 0.07)).

Nutrient restriction between early to mid-gestation, followed by adequate feeding up to term, is associated with larger offspring who exhibit lower blood pressure at 6 months, but an increase in blood pressure response to a vasoconstrictor challenge. This suggests that alterations in maternal nutrition at specific stages of gestation may contribute to hypertension in later life through concomitant physiological and vascular changes.

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The influence of different stimuli on energy expenditure and food intake. By V. LIM, C.J.K. HENRY and R. RAMSBOTTOM, Nutrition and Food Science Group, School of Biological and Molecular Sciences, Oxford Brookes University, Gipsy Lane Campus, Headington, Oxford OX3 0BP

A positive energy balance occurs only when energy intake (EI) is greater than energy expenditure (EE). Continued positive EI will result in weight gain and may lead to obesity. However, the factors that influence energy balance are not fully understood. Few studies have investigated the influence of EE on EI and the effect of the respiratory quotient (RQ) on the food quotient (FQ) (Verboekrt-van-de-Venne & Westerterp, 1991). If an individual is in energy balance, RQ must equal FQ (Flatt, 1987). Therefore, it may be hypothesized that individuals who have a mismatch between the FQ and the RQ may be more likely to become obese.

The aim of this study was to investigate the relationship between (1) RQ and FQ, and (2) EE and EI for three different stimuli: cold exposure, caffeine, and exercise, all aiming to expend 839 kJ.

Fourteen male subjects, aged 18 to 35 years, underwent a programme involving a control day and three test days. Each subject acted as his own control. One subject failed to complete all four test days and was excluded from the study. Food intake, presented as a buffet meal, was covertly monitored by weighing the food before and after meals. This was to determine the subject's food selection and intake. Diet 5 for6 Windows was used to analyse the dietary data.

Test day n 13	RMR[††] (kJ/day) Mean (SD)	EI(kJ) Mean (SD)	REE[†] (kJ/min) Mean (SD)	EI/RMR Mean (SD)	Resting RQ Mean (SD)	RQ Mean (SD)	FQ Mean (SD)
Control	6945 (946)	5732 (1202)	5.5 (0.63)	0.86 (0.24)	0.84 (0.05)	0.84 (0.05)	0.85 (0.03)
Cold	7109 (602)	6054 (1623)	29.2 (3.85)***	0.89 (0.26)	0.88 (0.05)	0.87 (0.06)	0.84 (0.04)
Caffeine	2701 (615)	5598 (1488)	30.0 (4.48)***	0.79 (0.20)	0.84 (0.05)	0.87 (0.05)	0.85 (0.03)
Exercise	6832 (703)	6046 (1620)	29.1 (3.72)***	0.89 (0.23)	0.87 (0.07)	0.92 (0.05)	0.85 (0.02)

Where [†]REE = rate of energy expenditure, and [††]RMR = resting metabolic rate. Significant difference between control and test day *** P<0.001.

The results to date suggest that RQ has no effect on the immediate FQ. Mean EI was not significantly different between the four tests (P 0.819). The ratio of EI to RMR was assessed in all four conditions and the following results were observed.

EI/RMR Cold v. Control   EI/RMR Caffeine v. Control   EI/RMR Exercise v. Control

y=0.89x+0.122 R²=0.6917

y=0.691x+0.1994 R²=0.5747

y=0.7535x+0.2443 R²=0.628
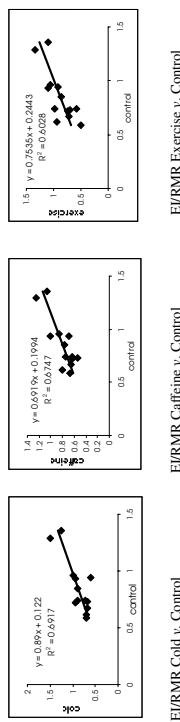
The results indicate that the ratio of EI to RMR appears to be tightly fixed in an individual and shows little change whatever the route of EE. This is the first time that the ratio of EI to RMR has been shown to be constant irrespective of the route or amount of EE. Further research is being done to investigate the relationship between EE and EI.

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The effect of feed restriction and realimentation on liver mRNA and plasma levels of insulin-like growth factor binding protein-2 (IGFBP-2) and IGFBP-3 in calves. By G.K. LEE and P.J. BUTTERY, *Division of Nutritional Biochemistry, School of Biosciences, University of Nottingham, Sutton Bonington Campus, Loughborough LE12 5RD*

The growth hormone IGF axis is one of the major factors controlling fat and lean deposition and has been shown to be sensitive to nutrition (Brameld, 1997; Dawson *et al.* 1998). Many ruminants receive a variation in the supply of nutrients during their lifetime, for example the quality of grass varies between summer and winter. The aim of this study was to investigate the changes of nutrient supply on the IGFBP in plasma and their mRNA expression in liver. Previous work has shown that severely reducing growth rates of bulls caused plasma IGFBP-3 to decrease and IGFBP-2 levels to increase; the levels of both binding proteins returned to that of normally growing bulls after realimentation for 100 d (Renaville *et al.* 2000). Few studies have been carried out on the effect on gene expression of these binding proteins during restricted and compensatory growth and how quickly they return to normal.

Weaned Friesian castrated calves (*n* 24, age 61 (SD 9) d, weight 100.2 (SD 9.5) kg) were individually housed and fed and randomly assigned to three groups: a control group (HIGH; *n* 8), fed a high plane of nutrition to induce 'normal' growth rates (1.04 kg/d), a restricted group (LOW, *n* 8), fed to 90% of maintenance to stop growth (-0.01 kg/d) and a realimented group (REAL, *n* 8), fed as the low group for 32 d to arrest growth (-0.04 kg/d), then realimented over 24 h to the high plane of nutrition of the control group to induce rapid growth rates (1.36 kg/d). Four calves from each group were slaughtered 48 h after realimentation, while the remainder were slaughtered 20 d after and liver samples frozen in liquid N_2.

IGFBP-2 and IGFBP-3 mRNA were measured using a ribonuclease protection assay. Plasma samples were collected hourly 42 h after realimentation for the next 6 h and pooled for the analysis of IGFBP-2 and IGFBP-3 using Western ligand blotting with biotinylated IGF-II. Slaughter time after realimentation had no effect on the expression of IGFBP-2 or IGFBP-3 mRNA. Both expression and plasma levels of IGFBP-2 were higher in the LOW group compared with the other groups ($P<0.001$). HIGH and REAL groups were not different, suggesting that IGFBP-2 mRNA and plasma levels had returned to control levels within 48 h of realimentation. Diet had no effect on IGFBP-3 mRNA in liver (p 0.73). However, plasma levels of IGFBP-3 were significantly higher in the HIGH group than the other groups ($P<0.05$), thus realimentation over 48 h failed to affect the plasma IGFBP-3 levels.
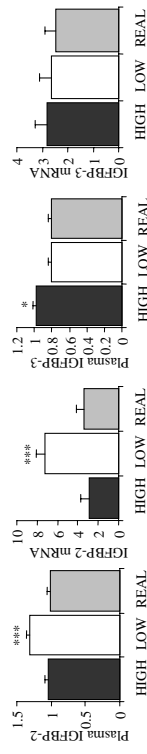
Data were analysed by ANOVA. Error bars are SED, *n*=8.

In conclusion, arresting growth rates resulted in a rise in liver expression and plasma IGFBP-2 levels; however, this rapidly reversed after realimentation. The expression of IGFBP-2 was unaffected by the changes in growth rate; however, the plasma levels dropped with growth arrest and failed to return to normal within 48 h of returning to a high plane of nutrition. This indicates that IGFBP-3 may be regulated by diet by post-mRNA mechanisms.

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The effect of fibre and fibre sources on plasma carotenoid levels: results from the UK Women's Cohort Study. By A.J. LONG, J.E. CADE, D.C. GREENWOOD and V. BURLEY, *Nutrition Epidemiology Group, Nuffield Institute for Health, 71–75 Clarendon Road, Leeds LS2 9PL*

Previous work has shown that NSP intake in a free-living population has an independent positive effect on plasma levels of carotenoids (Cade *et al.* 2001). We have explored this in more depth, investigating Southgate fibre and fibre sources and their effect on plasma carotenoid levels.

This sub-study is nested within the UK Women's Cohort Study and consists of a sample of 283 women of whom 274 had fasting blood samples taken. Dietary data was assessed by a 4 d food diary. The women were of relatively high socio-economic status with a low proportion of smokers and a high percentage of vegetarians/vegans. (Cade *et al.* 2001). The mean daily Southgate fibre consumed was 21.2 g, of which 43% came from cereal and cereal products, 27% from vegetables and 21% from fruit.

Multiple regression modelling was used to examine the relationships between fibre (Southgate) and fibre sources with reference to plasma carotenoid levels, adjusting for age, BMI, drinking tea with meal, current smoking status, intake of vitamin A, total calorific intake and general health. All nutrient values were log transformed.

Source of Southgate fibre	Percentage increase in plasma carotenoids for a doubling in Southgate fibre (95% CI)				
	β-Carotene	α-Carotene	Lutein	Cryptoxanthin	Lycopene
All sources	17.0	8.2	22.7*	24.4*	17.4
	−4.7 to 42.7	−10.3 to 30.5	7.8 to 39.6	2.1 to 51.7	−1.9 to 40.4
Cereal	−6.6*	−8.4*	−2.2	−2.9	1.3
	−11.7 to −5.3	−12.6 to −4.0	−5.9 to 16.5	−8.0 to 2.5	−31.2 to 87.9
Fruit	1.3	4.8*	4.4*	8.1*	0.7
	−23.7 to 5.3	1.2 to 8.5	1.5 to 7.3	4.0 to 12.3	−2.9 to 4.3
Vegetables	7.0	7.6	11.3*	0.6	14.4*
	−3.5 to 18.5	−1.8 to 17.7	4.4 to 18.8	−8.9 to 11.3	4.2 to 25.6

*$P<0.05$.

Plasma α- and β-carotene are negatively affected by the consumption of cereal and cereal products (see table); however, there is a positive relationship between plasma α-carotene and fibre from fruit. Plasma lutein levels showed a statistically significant positive increase with total Southgate fibre and, in particular, fibre from fruit and vegetables. The pattern was similar for plasma cryptoxanthin. Lycopene in the blood showed a 14.4% increase for a doubling of Southgate fibre intake from vegetables.

These results address a gap in the literature by examining the effect of long-term fibre intake in a free-living population consuming their usual diet. Overall, fibre appears to have a positive effect on plasma levels of carotenoids. The food source of this fibre is important. Fibre (Southgate) from cereals seems to have a negative effect on carotenoids, whereas that from fruit and vegetables has a positive effect on carotenoid levels in the blood. This adds weight to the public health message that increasing fruit and vegetable consumption is beneficial for health.

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A human study investigating the effects of increased fruit and vegetable consumption in smokers. By W.G. ROBERTS, M.H. GORDON and A.F. WALKER, *Hugh Sinclair Unit of Human Nutrition, School of Food Biosciences, University of Reading, PO Box 226, Whiteknights, Reading RG6 2AP*

Epidemiological evidence associating greater fruit and vegetable intake with a lower risk of coronary heart disease has been attributed to antioxidants which are thought to inhibit free-radical-mediated oxidative damage of low-density lipoproteins (LDL). Fruits and vegetables contain many different antioxidant components, including ascorbic acid, α-tocopherol, carotenoids and polyphenols. These compounds have been shown to inhibit lipid peroxidation *in vitro*, and consumption of a mixture of antioxidants may provide greater protection *in vivo* than large doses of single antioxidants. Trials examining the effects of increased fruit and vegetable consumption have used fruit and vegetables containing particular classes of antioxidants or supplemented subjects with a high level of fruit and vegetables in a controlled environment (Hininger *et al.* 1997; Miller *et al.* 1998). Current dietary guidelines recommend the consumption of five portions of fruit and vegetables per day (Department of Health, 1994). The effects of an increase of this magnitude upon the antioxidant status and the oxidative stability of LDL of free-living subjects are untested.

The objective of this study was to investigate whether supplementation with five portions of fruit and vegetables per day could significantly increase *in vivo* antioxidant concentrations and resistance to lipid peroxidation. Smokers, who have been shown to have lower antioxidant intakes than non-smokers (Ma *et al.* 2000), were supplemented with fish oil to increase their oxidative stress. Eighteen smokers, whose usual diet was low in fruit and vegetables, were supplemented for 9 weeks with 4 g fish oil in capsule form (containing 1200 mg EPA, 828 mg DHA). Subjects continued eating their usual diet for weeks 1–3 and increased their fruit and vegetable consumption by five portions per day for weeks 4–6 before returning to their usual diet for weeks 7–9. Fasting blood samples were taken at the ends of weeks 0, 3, 6, and 9.

No significant differences in plasma antioxidant concentrations were seen when subjects were supplemented with fish oil from weeks 0 to 3. However, the plasma concentration of ascorbic acid increased from 49.4 to 63.3 μmol/l when fruit and vegetable intake was enhanced in weeks 3 to 6 (P<0.02). Plasma concentrations of lutein, β-cryptoxanthin, α-carotene and β-carotene in week 3 were 178, 88, 68 and 244 nmol/l. After enhanced fruit and vegetable intake plasma concentrations had increased significantly to 214, 211, 99 and 433 nmol/l respectively (P<0.05). Plasma concentrations of α-tocopherol, retinol and uric acid did not change significantly throughout the study. Plasma oxidative stability, assessed by the oxygen radical absorbance capacity (ORAC) assay, was 528 Trolox equivalents in week 6 compared to 482 Trolox equivalents in week 3 (P<0.002). Lag phase before oxidation of LDL decreased from 82.5 to 69.3 minutes in the first 3 weeks of the study, reflecting the incorporation of EPA and DHA into LDL (P<0.0001). After three weeks of enhanced fruit and vegetable consumption susceptibility of LDL to oxidation was reduced with the lag phase before oxidation of LDL increasing to 76.7 minutes (P<0.005).

Enhanced fruit and vegetable consumption increases plasma antioxidant capacity and improves oxidative stability of LDL *ex vivo* in smokers consuming fish oil. Five portions of fruit and vegetables per day are sufficient to produce significant beneficial physiological effects.

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The effect of acute ingestion of fruit and vegetables on whole blood platelet aggregation: a pilot study. By G.P. HUBBARD[1], L.C. BOURNE[1], I.A. LOVEGROVE[1], J.M. GIBBINS[2] and C.M. WILLIAMS[1], *[1]Hugh Sinclair Unit of Human Nutrition, School of Food Biosciences, University of Reading, Whiteknights, Reading, Berks RG6 6AP and [2]School of Animal and Microbial Sciences, University of Reading, Whiteknights, Reading, Berks RG6 6AP*

There is increasing evidence that the consumption of a diet rich in fruit and vegetables is associated with a reduction in the incidence of heart disease (Hertog *et al.* 1995). Fruits and vegetables are known to contain high levels of the antioxidant vitamins C and E; however, they also contain another group of antioxidants called the flavonoids. Previous work on the effects of vitamin C, vitamin E and flavonoid supplementation on platelet function (Beretz *et al.* 1982; Freedman *et al.* 1996) has shown inhibition of platelet function after *in vitro* addition of these compounds. A human dietary study was undertaken to determine the acute effects on platelet aggregation of ingestion of a meal rich in fruit and vegetables (high in flavonoids and antioxidants). The volunteers' background diets were standardized to exclude all dietary sources of flavonoids and antioxidants other than a serving of five standard portions of fruit and vegetables which were provided to volunteers as a lunch each day for a 5 d period. The meal consisted of a salad starter, a vegetarian main course (pasta and sauce), a fruit dessert and a grape juice drink. Twenty volunteers: ten male and ten female, followed a fruit and vegetable-free diet, except for the study meal described above, for a 5 d period. They attended the Human Investigation Unit at the Hugh Sinclair Human Nutrition Unit each day and were provided with the study meal at lunchtime. On day 5, blood samples were taken before ingestion of the meal and 3 h after ingestion.
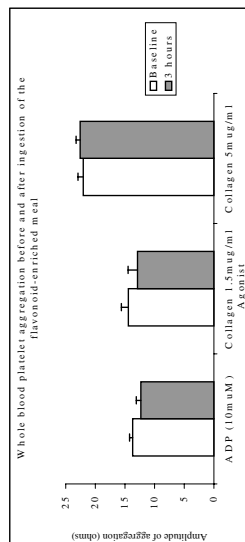
Whole blood platelet aggregation was carried out on a chronolog aggregometer. Collagen (1.5 and 5 μg/ml) and ADP (10 μM) were used as agonists. Whole blood platelet aggregation decreased by 10% with ADP and collagen (1.5 μg/ml) after acute ingestion of the meal, however this change was not significant. Further work is required to determine the true benefit of fruit and vegetable consumption on platelet function.

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Effect of fluid ingestion rate on post-exercise rehydration in human subjects. By D.T. ARCHER and S.M. SHIRREFFS, *Biomedical Sciences, University Medical School, Foresterhill, Aberdeen AB25 2ZD*

Dehydration resulting from exercise-induced sweat loss may limit physical performance. Rapid, complete and sustained post-exercise rehydration is essential to restore hydration status and subsequent exercise performance (Maughan, 1997). The present study examined the effectiveness of post-exercise consumption of a carbohydrate–electrolyte drink ingested over either a 30-min (30M) or 90-min period (90M) after exercise. Rapid ingestion of low-sodium fluids causes a fall in plasma osmolality and an increase in blood volume that results in diuresis (Maughan, 1997). Drink ingestion over a longer period may attenuate this response and minimize fluid loss over the recovery period.

With local ethics committee approval, six healthy subjects (four males, two females; age 23 (SD 2) years, height 172 (SD 9) cm, body mass 70.6 (SD 9.8) kg) were dehydrated by 2.0 (SD 0.1) % of body mass by intermittent cycle exercise in a warm (34.2 (SD 0.2)°) humid, (62 (SD 3)% rh) environment. Beginning 30 min post-exercise they drank a commercially available sports drink (6% CHO, osmolality 288 (SD 1) mosmol/kg, 21 (SD 1) mM [Na$^+$]) in a volume corresponding to 150% of their body mass loss. Urine and blood samples were obtained before exercise, 30 min after exercise and every 30 min until 4 h post-exercise. For each urine sample, the bladder was emptied as completely as possible and blood samples were taken after at least 15 min of seated rest. Blood and plasma volume changes were calculated from haemoglobin and packed cell volume values (Dill & Costill, 1974). Data were analysed by repeated measures ANOVA, *t*-tests and one-way ANOVA with *post hoc* Tukey tests where appropriate.

Cumulative urine volume from the start of drinking (Post-Ex to 4 h) was greater (*P*<0.05) for 30M (932 (SD 271) ml) than for 90M (823 (SD 242) ml). Net fluid balance (NFB) is equal to fluid gains (drinking) minus fluid losses (dehydrating exercise and urination) at each time point. Due to the greater urine production in 30M, subjects were in a more negative NFB (*P*<0.05) at 4 h post-exercise in the 30M trial (see table). Change in plasma volume was greater (*P*<0.05) at 1:30 h in 30M (see figure).

NFB (ml)	30M Mean	SD	90M Mean	SD
Pre-Ex	0	0	0	0
Post-Ex	−1443	158	−1430	78
0.30 h	668*	107	−731	92
1 h	638*	124	−37	20
2 h	290	241	422	106
3 h	−91	257	63	217
4 h	−257*	261	−136	232

*Significantly different from 90M: *P*<0.05.

Plasma Volume Changes (%)

*Significantly different from 90M: *P*<0.05. *Significantly different from 30M: *P*<0.05.

The greater haemodilution observed in 30M, as indicated by the plasma volume expansion, was the most likely factor responsible for the greater urinary fluid losses and more negative NFB. This hypervolaemia and associated greater decrease (*P*<0.05) in serum osmolality at 1 h (−2 (SD 3) *v*. +2 (SD 3) mosmol/kg) and 1:30 h (−4 (SD 5) *v*. +1 (SD 3) mosmol/kg) in 30M could cause the greater urinary losses through changes in the release of fluid-balance hormones. Reduced vasopressin levels lead to a decrease in renal tubular permeability to water and increased water excretion, and decreased aldosterone levels lead to lower sodium reabsorption. In summary, the rate of drinking of a carbohydrate–electrolyte drink can affect post-exercise rehydration.

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Negative associations between fasting triacylglycerol (TAG) and indicators of adiposity in Sikh men living in the UK. By S. LESAUVAGE, S. LOVEGROVE, J.A. LOVEGROVE and C.M. WILLIAMS, *Hugh Sinclair Unit of Human Nutrition, School of Food Biosciences, The University of Reading, Reading, RG6 6AP*

The high rate of cardiovascular disease (CVD) in Asian Indians compared with other ethnic groups was first reported 40 years ago. The high prevalence of abnormalities in glucose and insulin metabolism could be at the heart of the increased risk of CVD among this ethnic group, particularly as it is combined with a greater tendency to central obesity. Forty-five Europeans (twenty-four men and twenty-one women) and forty-three Sikhs (twenty-six men and seventeen women) living in the UK, matched for age (48 years), BMI (25.8 kg/m^2 European; 26.0 kg/m^2 Sikhs) and blood pressure (127/76 mmHg Europeans; 127/78 mmHg Sikhs; BP) were recruited as part of a fish-oil intervention trial. Baseline fasting plasma lipids and anthropometric measurements were assessed in men and women of the two ethnic groups. TAG and non-esterified fatty acids (NEFA) were significantly higher in Sikh men than in European men, while percentage body fat, as measured by bioimpedance, was significantly higher in Sikh women than in European women (see table).

Mean	Men		Women	
	Europeans (*n* 24)	Sikhs (*n* 26)	Europeans (*n* 21)	Sikhs (*n* 17)
TAG (mmol/l)	1.24	2.08§	1.07	1.07
NEFA (μmol/l)	310	378‡	404	419
Total cholesterol (mmol/l)	5.40	5.53	5.08	5.17
HDL-cholesterol (mmol/l)	1.34	1.23	1.59	1.46
LDL-cholesterol (mmol/l)	3.49	3.35	3.00	3.22
Waist circumference (cm)	96.2	94.4	80.0	81.5
Waist:hip ratio	0.89	0.91	0.77	0.77
Waist:height ratio	0.54	0.55	0.48	0.52
% body fat (from skinfold measures at four sites)	20.8	20.8	31.7	33.1
% body fat (bioimpedance)	22.9	24.8	32.4	37.8*

Comparisons between Europeans and Sikhs for fasting lipaemia and anthropometric measurements. Ethnic groups are compared within gender: §*P*<0.001, ‡*P*<0.05, both Mann-Whitney, **P*<0.05 Student's *t*-test.

Statistical associations between circulating TAG levels and measures of adiposity were determined in each of the four groups. Interesting differences were noted between the Sikh men and the three other groups with regard to associations between fasting TAG and measures of adiposity. In Sikh men, unexpected negative associations were found between TAG and percentage body fat calculated from skinfold measurements at four sites (Pearson's *r* −0.387, *P*<0.05), whereas the expected positive association was observed in European men (*r* 0.456, *P*<0.05). European women (*r* 0.449, *P*<0.05) and Sikh women (*r* 0.450, NS). The same trends were re observed between TAG and measures of central adiposity (waist circumference and waist:height ratio). Recent work in our group has shown similar negative associations between central adiposity and circulating TAG in men with an atherogenic lipoprotein phenotype (Minihane *et al.* 2000). These data suggest that factors other than total body mass and its distribution are determinants of circulating TAG levels in South Asian men.
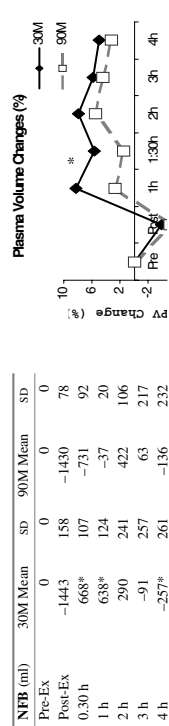
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Influence of gymnastic training and nutrition on bone 'quality' in pre-pubertal and pubertal girls: preliminary data from a 24-month longitudinal study. By J.A. NURMI, J.A. BISHOP and S.A. NEW, *Centre for Nutrition and Food Safety, School of Biomedical and Life Sciences, University of Surrey, Guildford GU2 7XH*

Peak bone mass (PBM) is predominantly achieved around puberty. Weight-bearing exercise together with diet and hormonal status are crucial factors influencing PBM development in children. Competitive gymnastics favours individuals with low body weight, which may lead to food restriction and over-training and be disadvantageous for bone development. Calcaneal quantitative ultrasound (QUS) is an alternative method for bone health assessment to the traditional technique of dual-energy X-ray absorptiometry (DXA) and is believed to provide important additional information on bone 'quality' (such as bone microarchitecture and elasticity), although this remains to be fully quantified. Compared with DXA, ultrasound is cheap, portable and includes no ionizing radiation. Data on QUS in children is sparse and it is not yet considered a valid tool for bone mass measurement in the younger population.

As part of a 24-month longitudinal investigation examining the potential synergistic effects of nutrition and physical activity on bone health in young females (Nurmi *et al.* 2001*a*) we now report the 12-month follow-up data on growth and bone 'quality' in a group of competitive gymnasts and controls. QUS measurements were undertaken in pre-pubertal and pubertal gymnasts (G) and controls (C) at baseline, 6 and 12 months (McCue Ultrasonics Ltd, Winchester, version 3.5).

		Pre-pubertal group						Pubertal group					
		G (n 24)		C (n 21)		1-year change (SD)		G (n 17)		C (n 31)		1-year change (SD)
		Mean	SD	Mean	SD			Mean	SD	Mean	SD	
Height (m)	Baseline	1.27[a]	0.1	1.35[b]	0.1	G:4% (1.2)		1.47[a]	0.1	1.56[b]	0.1	G:4% (1.7)
	12 months	1.33[a]	0.1	1.41[b]	0.1	C:4% (0.8)		1.52[a]	0.1	1.61[b]	0.1	C:3% (1.7)
Weight (kg)	Baseline	25[a]	2.8	32[b]	5.4	G:11% (3.8)		39[a]	6.2	47[b]	9.5	G:15%(6.4)
	12 months	28[a]	3.6	37[b]	7.0	C:14% (5.5)		43[a]	4.8	52[b]	9.7	C:10%(6.3)
Energy (kJ/d)	Baseline	7.1	1.6	7.6	1.0			7.0	1.4	7.7	1.2	
	12 months	6.8	1.3	7.0	1.4			7.3	0.9	8.0	1.9	
BUA (dB/MHz)	Baseline	47	11	45	11	G:+7% (30)		71[a]	17	57[b]	15	G:+6% (17)
	6 months	52	13	46	11	C:+0.4% (18)		78[a]	14	56[b]	16	C:+6% (14)
	12 months	47	6	46	9			75[a]	14	61[b]	15	
VOS (m/s)	Baseline	1714[a]	25	1682[b]	28	G:-0.9% (2)		1741[a]	42	1686[b]	41	G:-0.5% (1)
	6 months	1718[a]	26	1676[b]	36	C:-0.5% (1)		1747[a]	30	1686[b]	40	C:-0.5% (2)
	12 months	1699[a]	22	1679[b]	28			1737[a]	34	1678[b]	38	

[a,b] Values with unlike superscripts were significantly different (independent Student's *t*-test), *P*< 0.05. BUA = broadband ultrasound attenuation, VOS = velocity of sound

Similar increases in height and weight between pre-pubertal and pubertal gymnasts and controls suggest that growth rate is not compromised in the gymnasts, although they were significantly smaller and lighter. Total energy intake remained constant throughout the study (Nurmi *et al.* 2001*b*). There were consistent differences in VOS (bone elasticity) between gymnasts and controls, irrespective of pubertal status, with gymnasts having significantly higher results. However, differences in BUA (bone mass) were only significant at the pubertal stage. These data suggest that bone 'quality' is better in the gymnasts and the differences are likely to be a result of the osteogenic impact of the physical training. Analysis of the longitudinal DXA-data and dietary intake will enable us to investigate further the combined impact of these exogenous factors on PBM development.

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Increasing plasma homocysteine concentrations within the normal range correlate with worsening arterial endothelial function in the lower but not upper limb in a healthy population. By N.C. PEGGE[1], R.C. FIELD[1], A.M. TWOMEY[2], I.F.W. McDOWELL[3], M.J. LEWIS[1] and M.W. RAMSEY[2], *Departments of [1]Pharmacology, Therapeutics and Toxicology and [3]Medical Biochemistry, University of Wales College of Medicine, Cardiff CF14 4XN and [2]Cardiac Centre, Morriston Hospital, Swansea SA6 6NL*

Disorders of homocysteine (Hcy) metabolism carry an increased risk of vascular disease. Hcy inhibits endothelium-dependent relaxation of isolated rabbit aortic rings *in vitro*, an effect blocked by a scavenger of intra-cellular superoxide anion, and the Hcy-induced increase in intra-cellular superoxide anion is blocked by the anti-oxidant vitamins C and E (Lang *et al.* 2000), suggesting an oxidative mechanism. Within middle-aged and elderly normal populations, plasma homocysteine levels in the highest quartile are associated with endothelial dysfunction (Woo *et al.* 1997). In healthy volunteers, modest postprandial elevations in homocysteine produce transient endothelial dysfunction (Chambers *et al.* 1999). Acute methionine loading increases plasma Hcy and worsens endothelial function, assessed by high-resolution ultrasound measurement of flow-mediated changes in brachial artery diameter (Bellamy *et al.* 1998). The relationship of fasting plasma Hcy with endothelial function in normal subjects is unknown.

260 asymptomatic volunteers (124 male, aged 20–73 years) were studied fasting. Exclusion criteria were pregnancy, diabetes mellitus, hypertension (blood pressure >160/90 mmHg), heart failure, any heart valvular disease; and stroke, myocardial infarction or angina within 3 months. Arterial endothelial function was assessed by recording minute by minute changes in brachioradial and femorotibial pulse wave velocity (PWV) during reactive hyperaemia induced by release of standard sphygmomanometer cuffs inflated to supra-systolic pressure at wrist and ankle for 5 min. PWV is inversely proportional to distensibility, and flow-mediated, endothelium-dependent vascular smooth muscle relaxation leads to a reduction in local arterial PWV. Venous blood was drawn without stasis from an antecubital vein into tubes containing EDTA and plasma was separated immediately by refrigerated centrifugation, and then frozen at –70° until assay.

Endothelial function was calculated as average percentage change in PWV in the first 5 min after release of cuff occlusion, and correlated against Hcy. Increasing Hcy levels were significantly correlated with worsening endothelial function in the leg (*r* = –0.164, *P* 0.022) with a similar but non-significant trend in the arm (*r* = –0.10), though this relationship was not significant in a multiple regression analysis including age and blood pressure in this small population. Thus, higher fasting Hcy levels in a healthy population are associated with impaired femorotibial vasodilator response to increased flow, with suggestion of a similar effect in the brachioradial segment.

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Nutritional interventions for menopausal symptoms: the reliability of measurement and the response prior to treatment. By S.M. HICKS and A.F. WALKER, *The Hugh Sinclair Unit of Human Nutrition, Department of Food Biosciences, University of Reading, Reading RG6 6AP*

Menopausal symptoms include physical symptoms such as hot flushes, night sweats and subsequent sleep problems, as well as various psychological symptoms such as anxiety and depression. As many women seek to use natural products as an alternative to hormone replacement therapy for treating menopausal symptoms, studies establishing efficacy are needed.

In order to measure treatment effects in intervention studies, one requires measuring instruments that are valid (actually measure what is intended), reliable (yield consistent results on repeated use in the absence of change) and responsive (able to detect small changes over time). Hence, to examine the reliability and responsiveness of questionnaires previously validated for measuring menopausal symptoms, we conducted a pilot study. This study included a no-treatment, run-in period of 6 weeks, and this baseline data is presented here.

Ninety-six menopausal women completed three disease-specific questionnaires weekly; the women's health questionnaire (WHQ; Hunter et al. 1992), the menopause-specific quality of life questionnaire (MENQOL; Hildtich et al. 1996) and visual analogue scales of menopausal symptoms (VAS; Wiklund & Karlberg, 1991). Furthermore, subjects also completed a more generic measure of well-being; the psychological general well-being schedule (PGWB; Dupuy, 1984), at the beginning and end of the 6-week period. The study showed the reliability of the disease-specific instruments to be 0.84 for the WHQ, 0.87 for the MENQOL and 0.84 for the VAS, suggesting that these instruments are reliable measures of menopausal symptoms. On examination of the mean weekly scores, it was seen that symptoms actually improved significantly over this baseline period. However, significant changes were not also seen in the PGWB, indicating the superior responsiveness of the disease-specific instruments to detect small changes in menopausal symptoms.

Menopausal symptoms over 6 weeks of no-treatment (mean of 96 subjects).
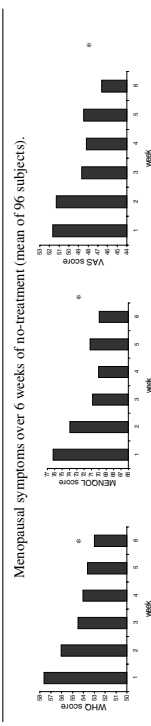
* Significantly different from week 1, $P \leq 0.003$.

This study illustrates the importance of questionnaire choice in clinical trials of subjective symptoms and well-being, especially when it is sought to detect relatively small changes, as is often the case in nutritional studies. It also shows how symptoms can respond in clinical trials, even in the absence of a prescribed intervention.

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Higher intakes of fruit and vegetables are associated with higher bone mass in perimenopausal Scottish women. By H.M. MacDONALD[1,3], F.H. DOWNIE[1], F. MOORE, S.A. NEW[2], D.A. GRUBB[4] 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*, [3]*Department of Medicine and Therapeutics, University of Aberdeen, Aberdeen AB25 2ZD and* [4]*Computing Department, Rowett Research Institute, Aberdeen AB21 9SB*

Intakes of K, Mg, Zn, fibre and vitamin C, that are indicative of a diet rich in fruit and vegetables, were found to be associated with higher axial and peripheral bone mineral density (BMD) and lower bone resorption in late premenopausal women (mean age 47.5 years; n 1064; New et al. 1997, 2000). Dietary intake was assessed using a food frequency questionnaire (FFQ), which had been previously validated using 7 day weighed intake records and markers of antioxidant status (New & Bolton-Smith, 1993; Bodner et al. 1998). BMD was measured by dual X-ray absorptiometry (Norland XR-26) at the lumbar spine (LS) and femoral neck (FN) sites. These women were a subset of the Aberdeen Prospective Osteoporosis Screening Study (APOSS) on over 5000 women who had a BMD scan in 1990–3 and again in 1997–2000, with 3646 women returning for the second visit (72.9% response rate). The women who did not complete a FFQ at the first visit were sent the questionnaire following the second visit. In total, we now have FFQ data from 3002 women according to the season of BMD scan (summer, April to September; winter, October to March; 82.3% response rate). We now report the results on fruit and vegetable intake. It should be noted that no exclusions have been made with regard to disease or medication and that these preliminary results include data from both under- and over-reporters. There was no significant difference in fruit and vegetable intake between the winter and summer attendees (mean total fruit:1695 g/week for winter, 1656 g/week for summer; mean total fruit and vegetables: winter 1813 g/week; summer 1825 g/week):

	n	Energy adjusted fruit only[a] Pearson coefficient				Energy adjusted fruit & vegetable intake[a] Pearson coefficient			
		LS BMD		FN BMD		LS BMD		FN BMD	
		r	p	r	p	r	p	r	p
Pre/perimenopausal women	325	0.131	0.018*	0.152	0.006*	0.091	0.099	0.120	0.030*
Postmenopausal women	955	-0.007	0.831	0.005	0.882	-0.032	0.317	-0.011	0.722
Past HRT users	615	0.070	0.084	0.089	0.030*	0.066	0.100	0.077	0.054
Current HRT users	1107	-0.061	0.979	-0.009	0.756	0.029	0.327	0.012	0.691

[a] Controlling for age, weight and height.

A significant association was found between fruit intake only and fruit and vegetable intake and BMD for women who were still menstruating and who had previously used hormone replacement therapy (HRT). For postmenopausal users and women currently taking HRT, the hormonal effect appears to be dominant. For women who have stopped taking HRT, it may be that the effect of hormones lessen with time and dietary influences (such as fruit and vegetables) may again play a positive role in bone health. Further investigations of the intriguing positive link between alkali-forming foods and the skeleton is certainly justified.

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Supplementation with a single cell oil, rich in docosahexaenoic acid elevates LDL cholesterol concentration in middle-aged healthy volunteers. By H.E. THEOBALD and T.A.B. SANDERS. *Nutrition, Food and Health Research Centre, King's College London, Franklin Wilkins Building, 150 Stamford Street, London SE1 9NN*

Intakes in the range of 2–5 g/d of docosahexaenoic acid (22:6*n*–3; DHA) and eicosapentaenoic acid (20:5*n*–3; EPA), provided as fish oil, lower plasma triacylglycerol (TAG) without influencing LDL cholesterol concentrations in healthy subjects (Sanders *et al.* 1997). The GISSI study (Anon. 1999) reported that long-term supplementation with 0.56 g DHA and 0.28 g EPA/d as ethyl esters derived from fish oil resulted in a statistically significant 3% increase in LDL cholesterol concentration compared with placebo in patients with CHD. DHA also causes downregulation of the LDL receptor *in vitro* (Lindsey *et al.* 1992). Oils produced by marine algae are being used in health-food supplements and yellow fat spreads as an alternative source of DHA to fish oil. We report the effects of long-term supplementation with a low dose of DHA-rich single cell oil (DHASCO) on serum lipid concentrations in healthy omnivorous subjects (twenty male, eighteen female, aged 40–65 years).

A randomized double-blind, placebo-controlled crossover study design was used; each treatment period lasted 3 months and was separated by a 4-month washout period. The active treatment consisted of 1.5 g DHASCO/d which supplied 0.68 g DHA and was provided in three opaque gelatin capsules; matching placebo capsules contained 1.5 g refined olive oil and similar concentrations of tocopherol and antioxidants. Blood samples were obtained by venepuncture after an overnight fast at the beginning and end of each treatment; serum lipids were determined on unfrozen serum within 3 d of blood collection. The results are shown below.

	DHA *n* 38					Placebo *n* 38					
	Baseline		3 months			Baseline		3 months			Treatment effect
	Mean	SEM	Mean	SEM		Mean	SEM	Mean	SEM		
Total cholesterol mmol/l	5.09	0.145	5.42***	0.174		5.03	0.168	5.15	0.155		+5.20%
LDL cholesterol mmol/l	3.16	0.127	3.45***	0.148		3.09	0.146	3.16	0.137		+9.20%
HDL cholesterol mmol/l	1.47	0.051	1.54	0.063		1.45	0.059	1.47	0.054		+4.5%
TAG mmol/l	1.03	0.094	1.01	0.089		1.06	0.106	1.19	0.103		−15.40%
Weight (kg)	70.1	2.04	70.6	2.06		70.5	2.01	70.6	2.01		0%

***$P<0.001$ compared with other values in the same row; repeated measures ANOVA with Bonferroni correction.

Serum total and LDL-cholesterol increased substantially on the DHA treatment, a finding not previously reported in other studies of DHASCO, which were either small, *n* 6 (Nelson *et al.* 1997), *n* 13 (Conquer & Holub, 1998) or conducted in vegetarians, *n* 12 (Conquer & Holub, 1996). Although substantial increases in LDL-cholesterol have been reported in patients with type IV hyperlipoproteinaemia treated with 3–5 g long-chain *n*-3 fatty acids as fish oil (Sanders, 1991), the mechanism involved (an increased proportion of small VLDL destined to form LDL) is an unlikely explanation for the current findings, as serum TAG was low. Some constituent of DHASCO other than DHA might be responsible for the increase in LDL cholesterol. Further work is being undertaken to elucidate the mechanisms involved.

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Phytoestrogens and the menopause: results from the UK Women's Cohort Study. By S. BOYLAN, J.E. CADE and D.C. GREENWOOD, *Nutritional Epidemiology Group, Nuffield Institute For Health, 71–75 Clarendon Road, Leeds LS2 9PL*

Preliminary clinical trials suggest that phytoestrogens may prevent or alleviate diseases or conditions associated with oestrogen deficiency, such as menopausal vasomotor symptoms (Nestel *et al.* 1997). These effects could be due to the oestrogenic activity of phytoestrogens. Previous studies regarding phytoestrogens and the menopause have mostly used dietary intervention in small samples of specific groups of women over a short period of time. We investigated the influence of phytoestrogens in a subgroup of the UK Women's Cohort Study (*n* 3076); a free-living female population consuming their own usual diet.

Using a 1-year, 277-item food frequency questionnaire (FFQ), we assessed the long-term phytoestrogen intake of the women. Additional questions regarding usual menstrual cycle length, infertility and use of HRT were asked. Women currently using the contraceptive pill and who had unfeasible values for menstrual cycle length were excluded from the analysis. The phytoestrogen content of foods, including the common soya foods, were derived from literature values (Reinli & Block, 1996; Liggins *et al.* 2000). The mean intakes of four phytoestrogens and the foods contributing most to phytoestrogens are shown in the following table.

(*n* 3076)	Daidzein (µg)	Genistein (µg)	Secoisolariciresinol (µg)	Matairesinol (µg)
Mean intake	1300 (605)	1661 (575)	11942 (9048)	1545 (1043)
Foods that contributed most to phytoestrogens	Coffee	TVP	Tea	Tea
	TVP	Bun/pastries	Potatoes	Potatoes
	White bread/rolls	White bread/rolls	Lentils/dals	Lentils/dals
	Wholemeal bread/rolls	Tofu	Broccoli/spring greens	Sunflow/sesame seeds
	Tofu	Wholemeal bread/rolls	Carrots	Courgettes/marrow/br occoli/spring greens
		TVP	Peanuts	

( ) = Standard deviation.

Phytoestrogen intake was correlated with factors relating to the menopause. All correlations between phytoestrogens and menopausal factors were weak and most were not statistically significant. There were small effects on doubling phytoestrogen intake on age of last period, and length of menstrual cycle. Associations were found between use of HRT and phytoestrogen consumption. Important contributors to daidzein and genistein were soya-based foods and bread. The lignans, secoisolariciresinol and matairesinol were mainly from tea, seeds, or specific vegetables.

Many studies have shown the beneficial effects of phytoestrogens on the menopause. Correlations in this study were weak, possibly due to lack of information on effects of cooking and processing on phytoestrogen content of foods. Confounding factors such as genetics, effects of medicines and supplements, individual intestinal flora, transit time, health, and hormone status have to be taken into account when looking at the effects of phytoestrogens on the menopause, and hence further studies are needed to gain the full picture.

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A city-wide survey of the diet, nutritional status and fitness of 9 and 10 year-old children in Liverpool according to receipt of free school meals. By A.F. HACKETT[1], M. GIBBON[2], G. STRATTON[1] and E. HAMILL[2]. [1]Liverpool John Moores University, School of Education, Community and Social Science, Barkhill Road, Liverpool L17 6BD and [2]Leisure Services Directorate, Liverpool City Council, Millennium House, Victoria Street, Liverpool L1 6JH

We have previously reported the dietary intake of children collected as part of the city wide *Sports*Linx project (Hackett *et al.* 2001), the main aims of which are to increase levels of physical activity in children, and to provide an annual supply of dietary and nutritional information on Liverpool children. This is a report of the nutritional status and fitness of Liverpool children collected as part of *Sports*Linx (a different cohort from the previous report).

All 122 primary schools in Liverpool were invited to take part and ninety-three did so, involving 4038 year 5 children (2033 boys, 1999 girls). Diet was recorded using a questionnaire based on intake of forty-six foods the previous day (only four are shown here). Fitness was assessed using the Eurofit tests. Nutritional status was indicated by measurements of height and weight (and skinfold thickness, data not shown). Data were analysed, for boys and girls separately, according to the proportion of children at each school entitled to a free school meal, using χ^2 test and analysis of variance.

| | Proportion of children entitled to free school meal | | | | | |
| | Lower third (2–22%) | | Middle third (24–53%) | | Upper third (54–100%) | |
	Boys	Girls	Boys	Girls	Boys	Girls
Diet (% eating each food yesterday):						
Fruit	69	73	72	72	68	71
Vegetables	41	46	41	39	40	37*
Fruit & vegetables	33	40	35	33	32	27*
Sugared drink	59	53	67	63	69**	64***
Take away meals	25	22	32	27	34*	28
Nutritional status (mean (SD)):						
Height (m)	1.384 (0.29)	1.371 (0.31)	1.371 (0.29)	1.363 (0.29)	1.368 (0.31)**	1.376 (0.33)**
Weight (kg)	33.4 (0.35)	33.3 (0.34)	32.6 (0.32)	33.0 (0.34)	32.5 (0.36)	33.5 (0.37)
BMI (kg/m²)	17.3 (0.14)	17.6 (0.13)	17.2 (0.14)	17.6 (0.13)	17.3 (0.14)	17.5 (0.15)
Fitness (only results for 3 of the 9 tests are shown) mean (SD):						
Balance (seconds)	16.8 (0.29)	16.8 (0.30)	17.9 (0.30)	18.1 (0.33)	16.2 (0.29)**	16.2 (0.35)**
Sprint (seconds)	22.4 (0.94)	23.3 (0.90)	23.0 (0.10)	23.8 (0.97)	22.9 (0.10)**	24.2 (0.12)**
Pull-ups (number)	6.1 (0.21)	4.0 (0.17)	8.2 (0.26)	5.4 (0.20)	7.8 (0.25)**	4.4 (0.19)**
Handgrip (kg)	15.5 (0.15)	14.3 (0.13)	15.4 (0.15)	14.4 (0.16)	15.6 (0.15)**	14.2 (0.10)**

**P<0.01, *P*<0.05.

Some 17% of boys and 23% of girls were classified as overweight or obese using the standards of Chinn & Rona (2001). *Sports*Linx is providing a detailed annual description of children's health in Liverpool which is already beginning to form the basis for intervention.

Chinn S & Rona RJ (2001) *British Journal of Medicine* **322**, 24–26.
Hackett AF, Gibbon M, Stratton G & Hamill E (2001) *Proceedings of the Nutrition Society* **60**, 66A.

Low-intensity exercise permits coupling between serum leptin and hunger-satiety in middle-aged obese women. By F. TSOFLIOU[1], Y.P. PITSILADIS[2], D. MALKOVA[1], M.A. WALLACE[3] and M.E.J. LEAN[1], [1]University Department of Human Nutrition, Glasgow Royal Infirmary, Glasgow G31 2ER, [2]Centre for Exercise Science and Medicine, Institute of Biomedical and Life Sciences, University of Glasgow, Glasgow G12 8QQ and [3]University Department of Clinical Biochemistry, Glasgow Royal Infirmary, Castle St, Glasgow G4 0SF

The role of leptin in appetite regulation in humans is unclear. Obese individuals have high circulating leptin levels but show weak appetite control with overeating and snacking. Since questions concerning the factors that regulate appetite in obesity remain unanswered, the objective of this study was to investigate the effect of low-intensity exercise or a snack on appetite sensations and on subsequent food intake in obese middle-aged women. The relationship between serum leptin levels and appetite sensations after low-intensity exercise or a snack was also investigated.

Ten obese women (age 50 (SD 9) years, weight 96 (SD 18) kg, and percentage body fat 47 (SD 4)%) were submitted in random order to three trials: 20 min brisk walk (L-EX), snack (58.5 g chocolate, S) and control (C). Sensations of appetite were assessed by Visual Analogue Scales (Flint *et al.* 2000) and blood was sampled over a 3.5 h period: baseline, pre- and post-intervention, 1 h post-intervention (i.e. before dinner) and immediately after a buffet-style dinner.

Immediately following the intervention, L-EX produced a higher feeling of satiety and fullness (compared to C) while S intake produced a lower perception of hunger (compared to C and L-EX), a lower desire to eat (compared to C), a lower perception of prospective food consumption (compared to C) and a higher perception of fullness and satiety (compared to C). The 1 h post-intervention (before dinner), L-Ex produced a higher feeling of satiety (compared to C), while S intake produced a lower desire to eat (compared to C) and a higher perception of satiety (compared to C). Serum leptin was correlated with appetite sensations immediately after exercise (*r* –0.83 prospective food consumption, *P* 0.003), 1 h post-exercise (*r* –0.79 hunger, *P* 0.007; *r* –0.69 desire to eat, *P* 0.02; *r* +0.71 satiety, *P* 0.02; *r* +0.66 fullness, *P* 0.03) and after dinner (*r* +0.67 hunger, *P* 0.03; *r* –0.71 satiety, *P* 0.02; *r* – 0.65 fullness, *P* 0.04) in the L-EX trial. Serum leptin was also associated with appetite sensations after dinner in the S (*r* –0.73 satiety, *P* 0.01) and in the C trial (*r* –0.79 satiety, *P*<0.006). There were significant positive correlations (*P*≤0.01) between serum leptin and body mass (*r* 0.76 L-EX; *r* 0.69 S; *r* 0.72 C), fat mass (kg) (*r* 0.87 L-EX; *r* 0.85 S; *r* 0.90 C) and a negative correlation (*P*<0.05) with fat free mass (%) (*r* –0.65 L-EX; *r* –0.65 S). Serum leptin did not differ between trials or over time. There was no significant difference in energy intake between trials (3020 (520) kJ L-EX; 2770 (280) kJ S; 3360 (1190) kJ C).

In conclusion, the relationship between leptin levels and appetite sensations found following low intensity exercise may indicate a possible effect for exercise-induced factors in the control of appetite.

Flint A, Raben A, Blundell JE & Astrup A (2000) *International Journal of Obesity and Related Metabolic Disorders* **24**, 38–48.

Estimation of portion sizes in children and adults using descriptions of the portion sizes and a photographic food atlas. By C. FROBISHER and S.M. MAXWELL, *Liverpool John Moores University, School of Education, Community and Social Science, IM Marsh Campus, Barkhill Road, Liverpool L17 6BD*

A major problem in dietary survey methodology is establishing portion sizes. Standard portion sizes and photographs of food portions have been used to estimate portion sizes for adults, but the use of these methods with children is debatable. The study involved thirty-seven subjects aged 16 years and under (mean age 11 (SD 2.6), range 7–16 years) and forty-seven subjects aged 18 years and over (mean age 40 (SD 11.6), range 18–58 years). Each subject was asked to serve the mself with their usual portion of selected food items. The food items were then removed and weighed. The subjects were asked to describe the portion they had just served themselves using the terms 'small', 'medium' and 'large'; the corresponding standard portion weights from Crawley (1992) were used to give the estimated portion sizes for the food items. At the same time the subjects were asked to express their portion sizes using the appropriate photographs in a food atlas (Nelson *et al.* 1997), to give a second set of estimated weights for each food item.

Food item	Subjects aged 16 y & under						Subjects aged 18 y & over					
	Mean actual wt (g)	SD	Mean % diff using description[1]	SD	Mean % diff using atlas[2]	SD	Mean actual wt (g)	SD	Mean % diff using description[1]	SD	Mean % diff using atlas[2]	SD
Baked beans	144	75	60	196	57	146	143	56	6	70	10	52
Cheese	44	8	−14	38	50	53*	36	14	13	58	74	68*
Chips	110	54	74	98	95	82**	121	43	36	41	39	52
Cornflakes	43	24	−11	39	1	32**	37	13	−1	36	9	37*
Margarine on bread	6	5	52	96	36	131	6	3	43	71	40	77
Mash potato	144	87	38	97	82	118*	194	85	6	48	34	48*
Rice	143	85	60	89	52	67	199	65	14	41	21	38
Spaghetti	156	98	102	128	52	71*	187	83	43	47	34	34

[1] % difference using estimated weights from the descriptions and Crawley (1992); calculated as ((estimated–actual)/actual wt) × 100 for each subject.
[2] % difference using estimated weights from the food atlas (Nelson *et al.* 1997): calculated as ((estimated–actual)/actual wt) × 100 for each subject.
*Significant difference between % difference from using description and food photographic atlas (Wilcoxon test) $P<0.01$.
**Significant difference between % difference from using description and food photographic atlas (Wilcoxon test) $P<0.05$.

Substantial differences in the mean estimate of portion sizes were observed for most foods regardless of the method used or the age of the subjects (difference range: −14 to 102%). For the majority of the food items the difference at the group level was higher in the subjects aged 16 years and under, compared with the subjects aged 18 years and over. At the individual level there was a wider range in the difference for the subjects aged 16 years and under than in those aged 18 years and over.

It would seem that for the subjects aged 16 years and under there were greater errors in using both the descriptions and the food atlas to determine portion sizes than in the subjects aged 18 years and over. Preliminary findings would suggest that either an alternative method or a modification of the methods used here for estimating portion sizes in young subjects would be more appropriate.

Crawley H (1992) *Food Portion Sizes*. London: MAFF.
Nelson M, Atkinson M & Meyer J (1997) *A Photographic Atlas of Food Portion Sizes*. London: MAFF.

Portion size estimation by primary school children. By E. FOSTER[1] A.S. ANDERSON[2] and A.J. ADAMSON[1], [1] *Human Nutrition Research Centre, University of Newcastle, Newcastle upon Tyne NE1 7RU and* [2]*Centre for Applied Nutrition Research, University of Dundee, Dundee DD1 4HN*

In order to assess nutrient intake, it is necessary to obtain a measure or estimate of portion size for each food consumed. As weighing all foods eaten requires subject time and commitment, a number of aids to assessing portion size have been developed including food photographs (MAFF, 1997). Portion size perception and conceptualization from food photographs and the accuracy with which they can be used to estimate portion size has been assessed with adults (Nelson *et al.* 1994, 1996) but this has not been extended to children. This paper reports the preliminary findings from a study comparing children's estimates of portion size of foods consumed at school dinners using food photographs with the weight of a typical serving of that food. The Bland Altman method was used to examine the accuracy with which children can use food photographs to estimate portion sizes (Bland & Altman, 1986). Percentage errors were also calculated using the formula (estimated weight − actual weight)/actual weight.
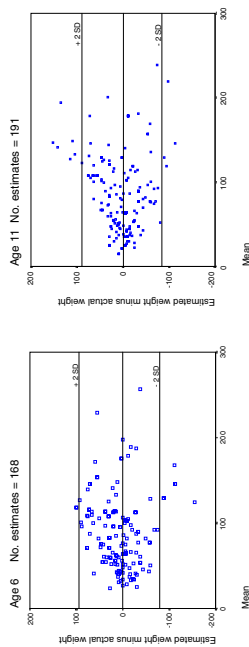
The Figure shows the difference between child estimates of portion size and the actual portion size served, against the mean of these two weights. Ideally all points would lie along the zero line, indicating no difference between the estimates and the actual portion sizes. Both ages showed a tendency to over-estimate small portions and to under-estimate large portions. There was a slight trend towards over-estimation in both age groups.

21% and 17% of portion size estimates by the 6 year-olds and 11 year-olds respectively were within 10% of the actual food weight. For 6 year-olds 45% and for 11 year-olds 44% of estimates were within 30% of the actual weight. Lucas *et al.* (1995) found around 50% of adults estimates of portion size from food photographs were correct to within 10% of the actual weight. However Nelson *et al.* (1996) found that 55% of portion size estimates by adults were correct only to within 30% of the actual weight.

Further work is currently under way to examine children's perception and conceptualization of portion sizes.

Bland JM & Altman DG (1986) *Lancet* **8**, 307–310.
Lucas F, Niravong M, Villeminot S, Kaaks R & Clavel-Chapelon F (1995) *Journal of Human Nutrition and Dietetics* **8**, 65–74.
MAFF (1997) *A Photographic Atlas of Food Portion Sizes*. London: MAFF Publications.
Nelson MM, Atkinson M & Darbyshire S (1994) *British Journal of Nutrition* **72**, 649–663.
Nelson MM, Atkinson M & Darbyshire S (1996) *British Journal of Nutrition* **76**, 31–49.

Food and nutrient content of meals chosen by secondary pupils under two different types of school meal provision. By W. L. WRIEDEN, A. BELL and P.J. LONGBOTTOM, *Centre for Public Health Nutrition Research, University of Dundee, Dundee DD1 9SY*

The Department of Education and Employment (1997) have recommended that the nutritional guidelines for school meals set out by the Caroline Walker Trust (1992) be used as a benchmark to review the progress of school meal contracts. The guidelines are set for energy and a selected range of nutrients which are markers of the quality of the diet and have particular roles in the maintenance of health. The DEE and Caroline Walker Trust standards for these nutrients are set such that the average amounts for a sample of meals provided over a 1-week period should meet the guideline figures.

During 1998/9, several different types of school meal provision were piloted in three secondary schools in Dundee, Scotland. For each day of recording (3–5 d per school) 50–100 records were made of the choices made by pupils. These were analysed using the ARMIS dietary analysis program (Tinuviel Software, Warrington) taking standard portion weights and recipe information provided by the caterers together with information from labels of packaged products. Mean intakes of energy and selected nutrients were calculated for the snack provision (various hot and cold snacks such as soup, sandwiches, hot filled rolls, baked potatoes will fillings, pizza, fresh fruit and yoghurt, but no chip, confectionery or standard carbonated sugar drink) and the results compared with the full service provision (which included a full range of hot and cold dishes, chips, confectionery and sugared drinks).

Meal provision	Full service (n 1011)		Snack (n 1218)		Guideline
	Mean	SD	Mean	SD	
Energy (MJ)	2.77	1.03	2.18***	0.77	2.70
Fat (% of energy)	41.5	8.64	42.2	12.0	≤35
Carbohydrate (% of energy)	46.8	10.1	39.9***	12.7	≥50
NSP (g)	3.50	2.36	2.53***	2.23	≥5.2
Fe (mg)	2.54	1.39	1.89***	0.96	≥5.9
Ca (mg)	223	184	316***	213	≥350
Folate (μg)	52.3	32.8	39.1***	31.9	≥80
Vitamin C (mg)	19.1	17.5	18.9	21.6	≥13

Mean values were significantly different from full service provision, ***$P<0.001$ (2-tailed t-test).

Neither type of meal provision met the guidelines suggested by the Caroline Walker Trust (1992). Mean energy, non-starch polysaccharides (NSP), iron and folate intakes were lower under the snack provision than in the full service provision. Mean vitamin C intakes were similar despite the fact that 19% of pupils chose fruit in the snack provision compared with only 3% in the full service provision. However, chips were present in 59% and crisps/corn snacks in 39% of meals in the latter. Providing chips, crisps, confectionery and sweetened drinks may be necessary to maintain numbers of pupils attending school meals in secondary schools, and to meet energy guidelines, but it should be noted that the availability of these foods is a barrier to pupils choosing more healthy options such as bread, baked potatoes and fruit.

Caroline Walker Trust (1992) *Nutritional Guidelines for School Meals. Report of an Expert Working Group*. London: The Caroline Walker Trust.
Department of Education and Employment (1997) *Eating Well at School – Dietary Guidance for School Food Providers. Part Three: For Catering Contract Managers and Caterers in School*. London: DEE Publications.

Investigating the use of variety indices as indicators of the nutritional adequacy of children's diets. By K.H. HART, P.Y. NG, J. CATTERICK, S.A. NEW, J. BISHOP and H. ANTHONY, *Nutrition Research Group, School of Biomedical and Life Sciences, University of Surrey, Guildford GU2 7XH*

Within the move towards developing food-based dietary guidelines the message 'Eat a variety of foods' is possibly the most widely promoted. However, there is little consensus as to the exact definition of variety or exactly what constitutes adequate dietary variety. Specifically, there has been little research as to the validity of using dietary variety indices as indicators of actual nutritional adequacy, with few researchers directly relating variety to nutrient intake and no such work carried out for children. It is, therefore, relevant to determine whether nutritional adequacy can be predicted from measures of dietary variety in children and hence whether this is a suitable message to promote for the school-age population.

A secondary analysis of sixty-two 7 d unweighed food diaries collected from 11- and 12 year-old schoolgirls in Surrey was undertaken (Catterick *et al.* 1998). All separate food items recorded in the diaries were listed (200 items) and subsequently grouped into nineteen minor food groups and six major groups with an additional group for miscellaneous items. Four types of dietary variety were then constructed using the following definitions: overall variety, variety among major food groups and variety within the major food groups, counting both minor groups and separate foods, in accordance with the methodology set out in Krebs-Smith *et al.* (1987). The diaries were analysed for individual nutrients using Diet 5 for Windows (Robert Gordon University, Aberdeen). Nutrient adequacy was measured via a truncated index of the percentage of the recommended intake for seven nutrients: protein, non-starch polysaccharides, calcium, iron, vitamin C, vitamin D, energy, as well as percentage energy from fat and percentage energy from non-milk intrinsic sugar. Possible scores for each nutrient ranged from 0 to 1 with an attainable total nutrient score of between 0 and 9. Stepwise multiple regression analysis was employed with nutrient score as the dependent variable and variety score, control measure (number of foods) and age as the independent variables. Due to the interrelation between variety and absolute number of foods consumed, a control variable counting the total number of foods, including repetitions, was entered into the analysis for each variety measure.

The variety measure alone was entered into the resulting models for overall variety and variety within the major groups, counting minor groups and separate foods, accounting for between 9 and 12% of the observed variance in nutrient score (Adjusted R^2=0.12, 0.09 & 0.11, respectively, $P<0.01$). However, the nutrient score was not significantly associated with the average number of major groups represented every day, measuring variety among the major groups. In this case the control variable, total number of foods eaten from the major groups, accounted for 5% of the variance (Adjusted R^2=0.05, P 0.05) with no other variable entered into the model.

Achieving variety among the major food groups is the message associated with The Balance of Good Health (Health Education Authority, 1994). However, in this study, such variety was unable to predict nutrient score, highlighting a need for further investigation into the appropriateness of 'adult' food grouping schemes in children's dietary guidelines. These preliminary findings suggest that simple variety indices alone may not be sufficient markers of dietary quality in children. Further work is needed with a larger dataset and a more sensitive measurement of nutrient adequacy in order to formulate a successful variety message for children.

Catterick J, Tredger J, Siggers L, Ruggles C, Matthews A, Thornton S & New SA (1998) *Current Research in Osteoporosis and Bone Health* **VI**, 131–132.
Health Education Authority (1994) London: Health Education Authority.
Krebs-Smith SM, Smiciklas-Wright H, Guthrie HA & Krebs-Smith J (1987) *Journal of the American Dietetic Association* **87**, 897–903.

Physical activity patterns in children aged 5–7 years. By S. PERWAIZ, J. WARREN, S. BRADSHAW and C.J.K. HENRY, *Nutrition and Food Science Group, School of Biological and Molecular Sciences, Oxford Brookes University, Gipsy Lane Campus, Headington, Oxford OX3 0BP*

The incidence of childhood overweight and obesity is increasing at an alarming rate. The causes of obesity are multifactorial and decreases in physical activity may be a key contributing factor. This study aimed to investigate the physical activity and television viewing levels of a group of primary school children during the week and at weekends.

The physical activity of a cohort of children aged 5–7 years from three Oxford primary schools was assessed as part of a wider health promotion intervention. Children (n 219) were asked about their playground activities and parents (n 158) completed a postal physical activity questionnaire on their children. Questionnaires were sent out throughout the year excluding summer. The questionnaire included the following aspects: mode of transport to and from school, time spent on weekday and weekend television viewing and other leisure pursuits.

The majority of children reported running around at mid-morning and lunch-time breaks (80% and 70%, respectively). Sleap & Warburton (1996) found that children tend to be more active during school breaks than during free time at home.

A higher proportion of children in our study walked to and from school compared with the National Diet and Nutrition Survey of Young People Aged 4–18 years (Gregory & Lowe, 2000) – 61% compared with around 50% in the same age group. However, the primary schools were situated within a small radius of the children's homes.

Of the children, 68% (n 108) watched television in the morning before school and 44% (n 69) of children watched 1–2 h television each weekday evening. The average television viewing was 10 h (sd 2·9, range 4–22) over the weekend. Overall, average daily television viewing was calculated to be 2·5 h, similar to recently reported figures (Livingstone & Bovill, 1999).

	None		<1 h		1–2 h		2–3 h		>3 h	
	%	n	%	n	%	n	%	n	%	n
Week-night TV viewing	6	9	38	60	44	69	9	14	3	5

It was found that 52% (n 82) of children participated in activities after school, with some children participating in more than one activity. The total number of after school activities was ninety and these were categorized according to their physical intensity.

Active activities		Moderate activities		Inactive activities	
%	n	%	n	%	n
36	56	8	12	21	32

Parents were asked to list the pursuits of children throughout the weekend and these were categorized according to physical intensity. Of all activities over the weekend, 12% were active, 26% were moderate and 62% were inactive; resulting in 33% (n 52) of the children being in active all weekend.

This study indicates that children are not meeting the Health Education Authority (1998) recommendations that all young people aged between 5 and 18 years should participate in at least 1 h of moderately intense activity each day. Primary schools in England and Wales have more than halved the amount of time allocated to PE lessons over the past 5 years. Only 11% of primary schools spend 2 h or more per week in PE lessons compared with 32% in 1994 – a decrease of almost two-thirds (Rowe & Champion, 2000). Furthermore, children tend to be more active at school rather than outside school. This poses a challenge when considering how children can best meet the recommendations for physical activity.

This work was funded by the Food Standards Agency.

Gregory J & Lowe S (2000) *National Diet and Nutrition Survey: Young People Aged 4 to 18 Years. Volume 1: Report of the Diet and Nutrition Survey.* London: The Stationery Office.

Health Education Authority (1998) *Young and Active.* London: Health Education Authority.

Livingstone S & Bovill M (1999) *Young People, New Media.* London: London School of Economics and Political Science.

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Sleap M & Warburton P (1996) *International Journal of Sports Medicine* **17**, 248–255.

Fruit and vegetable consumption by young persons aged 4 to 18 years: total daily number of portions. By J.M. HUGHES[1] and CM GAY[2], [1]*Independent Nutrition Consultant, Surrey RH1 4NW* and [2]*Economic, Mathematical and Statistical Advice Unit, Food Standards Agency, London WC2B 6NH*

The Government has set targets to reduce deaths from coronary heart disease and stroke, and from cancer, by 20% by 2010. Low consumption of fruits and vegetables is recognized as a risk factor for both coronary heart disease and some cancers. Campaigns to increase fruit and vegetable consumption are being mounted, particularly focusing on known 'low consumer' groups such as school children and young people.

To evaluate such campaigns it is necessary to have baseline consumption figures to monitor changes in consumption and to measure progress towards targets (generally measured as number of portions). Data from the National Diet and Nutrition Survey (NDNS) of a representative sample of young people aged between 4 and 18 years living in private households in Great Britain, carried out between January and December 1997 (Gregory *et al.* 2000), have been used to provide baseline figures of consumption. Analyses were carried out to determine mean portion sizes/weights, i.e. the amount consumed at a meal occasion, for eight age/sex groups (see table) for fruit juices (1 code), vegetable juices (1 code), fruits (40 codes), vegetables (40 codes) and pulses (mainly baked beans) (3 codes). In general, mean portion weights of fruits and cooked vegetables increased with age and the proportion of consumers decreased with age. Girls tended to consume slightly smaller portion weights than boys in each age group. Salad vegetables showed a slightly different pattern of portion weights and proportion of consumers in the groups. There was considerable consistency in portion weights, with only small increases with age; however, unlike cooked vegetables, the proportion of consumers generally increased with age. The mean portion weights were used to determine the mean daily total number of portions of all fruits (including juice) and all vegetables (including pulses) consumed by young people living in England (see table).

	Daily total number of portions of all fruits (plus juice) and vegetables							
	n	Min	Mean	Median	Max	SD	% consumers	% consuming 5 portions or more
Boys 4–7 y	208	0	2.2	1.8	10.8	1.48	98.4	4.1
Girls 4–7 y	196	0	2.4	2.2	9.5	1.55	97.9	4.5
Boys 8–10 y	171	0	2.1	1.8	6.0	1.30	97.7	3.2
Girls 8–10 y	149	0.03	2.4	2.3	7.9	1.42	100.0	4.3
Boys 11–14 y	209	0	1.8	1.6	7.5	1.23	99.3	2.9
Girls 11–14 y	210	0	2.0	1.7	9.1	1.41	98.5	3.7
Boys 15–18 y	162	0	1.8	1.4	9.3	1.46	97.5	4.9
Girls 15–18 y	183	0	2.3	1.9	17.5	1.86	97.4	5.5

It is apparent that the number of portions of fruit and vegetables consumed daily by this age range is well below the five or more portions daily recommended for good health. Promotion of increased consumption of fruit and vegetables in this age group is warranted. These data, although collected in 1997, can be assumed to be the baseline data for any current initiatives.

Gregory J, Lowe S, Bates CJ, Prentice A, Jackson LV, Smithers G, Wenlock R & Farron M (2000). *National Diet and Nutrition Survey: Young People Aged 4 to 18 Years, Volume 1: Report of the Diet and Nutrition Survey.* London: The Stationery Office.

A comparison of nutritional and diet status between Brazilian Indians and non-Indian children from a similar socio-economic background. By M.C. DE SOUZA[1], A.O.K.F. SOUZA[1], K.C. CUELHAR[1] and M. OSHIWA[2], [1]*Faculdade de Ciências da Saúde, Curso de Nutrição, Universidade Metodista de Piracicaba – UNIMEP Campus Lins, Brazil and* [2]*Departamento de Bioestatísitca, Instituto de Biociencias, Universidade Estadual Paulista, São Paulo, Brazil*

The approach of white civilization has exposed the Brazilian Indian to new habits, imposing changes to their lifestyle and affecting their health (Coimbra Junior & Santos, 2000). The child population is the most exposed to these changes (Coimbra Junior & Santos, 2000). Data from general population showed that malnutrition is the main cause of death in children under 5 years of age in Brazil (Benicio & Monteiro, 1997).

The study aims to compare 4–6 year-old Indian children from Dourados, Mato Grosso do Sul, with non-Indian children from the periphery of Lins, São Paulo, Brazil and the socio-economic impact on their nutritional and diet status. The study was submitted to the scrutiny of the Methodist University by the Piracicaba Academic Committee. Anthropometric measurements (weight (kg), height (cm)), food frequency of the family diet and socio-economic (child's family income and living standard) assessments were made on thirty-three Indian children from three different ethnic groups (Terena, Guarani and Caiwa) and forty-three children from Lins city. Both populations were on very low monthly incomes (Dourados Indians, on average US$ 58.00, and Lins on average US$ 88.50) and had poor living conditions. Most of the Indian families (87%), with an average of 5–7 members, were living in unsafe housing conditions in one room without water, sewerage, light and sanitation and most of the Lins families (96%), with an average of 3–4 members, were living in poor houses with an average of three rooms with sewerage, water, light but very poor sanitation.

Preliminary analysis of the diet data showed no statistically significant differences between groups. Each family was visited on three different occasions and the foods available were recorded. High carbohydrate foods (rice, pasta and beans) were the main diet for 100% of the families in both groups. Not many families included milk (55%), fruit and vegetables (35%) and red or white meat (44%) in their daily intake. Biscuits and soft drinks were eaten by 44.8% and 10.3% of the Indian families and 36% (for both products) of the non-Indian families. With reference to nutritional status using the NCHS standard (NCHS, 1987), most children in both groups were percentile 90 (normal), there were no more children, and 27% of the Indian children (two Guaranis and seven Caiwas) and 6.9% of the children from Lins were on percentile 5, classified as stunted. The study concludes that there is no difference in food intake within the two groups of children due to their socio-economic conditions. However, poverty and its consequences is an indicator of the culture change experienced by the Brazilian Indians, which has influenced their traditional eating patterns and nutritional status.

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Dietary intake and sources of phylloquinone (vitamin K₁) of a sample of adolescents in Cambridge, UK. By C.J. PRYNE, A.A. PAUL, D.C. GREENBERG, C. BOLTON-SMITH, S.J. STEAR, S.C. JONES and A. PRENTICE, *MRC Human Nutrition Research, Elsie Widdowson Laboratory, Fulbourn Road, Cambridge CB1 9NL*

It is now recognized that vitamin K has an essential role in the synthesis of proteins involved in bone mineralization (Shearer, 1997). Osteoporosis in old age is related to the peak bone mass achieved in young adult life. Here, a first assessment of the vitamin K_1 (K_1) content of the diets of this age group is reported. Male and female students from the Cambridge area between the ages of 16 and 18 years were recruited to take part in the Cambridge Bone Study. As part of the study, each completed a 7 d food diary based on household measures. These diaries were coded and analysed using the in-house program to calculate the nutrient intake of the subjects. The vitamin K_1 content of a wide range of foods was provided by Bolton-Smith *et al.* (2000 and unpublished).

	Boys (n 111)		Girls (n 101)	
	Median	95% CI	Median	95% CI
K_1 intake (µg/d)	72	66, 85	70	64, 78
K_1 intake (µg/4.18MJ/d)	27*	25, 29	32	30, 35
K_1 intake (µg/kg body wt. per d)	1.1	1.0, 1.2	1.2	1.1, 1.3

*Significantly lower than the girls, Mann–Whitney U test; P 0.01.

The mean daily intake of vitamin K_1 of both boys (82 µg, SD 42) and girls (75 µg, SD 33) was above the guideline for safe and adequate intake of 1 µg/kg body weight (Department of Health, 1991) and higher than the 72 µg/d for men and the 64 µg/d for women reported from Scotland (Price *et al.* 1996). When vitamin K_1 was expressed in relation to energy intake, the boys' median intake was significantly lower than that of the girls.

	Boys (n 111)		Girls (n 101)	
	Mean	Range	Mean	Range
K_1 from cereals and cereal products (%)	14	1–47	16	2–62
K_1 from spreading fats and oils (%)	5	0–27	5	0–54
K_1 from leafy vegetables (%)	24	0–78	27	0–70
K_1 from other vegetables (%)	13	1–47	14	0–43
K_1 from potato products (%)	12	0–49	9	0–29

Vitamin K_1 intakes on an individual daily basis ranged very widely, 4 µg to 1316 µg, because a few foods, such as spinach, are extremely rich sources. Spinach contributed nearly 5% of the total vitamin K_1 intake of both sexes although it was eaten on only nine occasions in the whole sample. Of the leafy green vegetables, lettuce was the main source that was eaten by the greatest number of subjects. The contribution from leafy green vegetables was in agreement with that reported for elderly subjects living in South East England (Thane *et al.* 2001). The vitamin K_1 from potato products derived mainly from the oil used to prepare these foods. Chips and potato crisps provided 5.5% of the vitamin K_1 intake of the boys and 2.8% of that of the girls. Apart from the vitamin K_1 present in the bran of whole grain cereals, most of that present in the cereal foods is also derived from the added fats. These sources may be more important as there is evidence that vitamin K_1 is better absorbed from fats than from vegetables (Gijsbers *et al.* 1996).

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Sources of dietary sugars *Laboratories in adolescents in 1980, 1990 and 2000.* By A.J. RUGG-GUNN, E.S. FLETCHER and A.J. ADAMSON, *Human Nutrition Research Centre, University of Newcastle, Wellcome, RVI, Queen Victoria Road, Newcastle upon Tyne NE1 4LP*

Reduction in the consumption of non-milk extrinsic sugars has been recommended (COMA, Department of Health, 1989); these sugars should provide no more than 10% of dietary energy (COMA, Department of Health, 1991). Surveys of about 400 Northumbrian adolescents in 1980 and 1990 revealed that non-milk extrinsic sugars (NMES) provided 16% and 17% of energy in the two surveys, respectively. A further study was undertaken in 2000 with the aims: (1) to determine the consumption of NMES, milk and intrinsic sugars, and total sugars in Northumbrian adolescents in 2000, and compare these with values obtained 10 and 20 years earlier; (2) to determine the sources of sugars in the diet of these adolescents, and compare these data with results 10 and 20 years earlier.

The subjects of the study attended the same seven middle schools in south Northumberland which had participated in the 1980 study (Rugg-Gunn *et al.* 1986) and the 1990 study (Rugg-Gunn *et al.* 1993). The numbers completing the three studies were 405, 379 and 424 (about 65% of those invited, in each study). Their mean age, in each survey, was approximately 11.5 years. In each survey, each child completed two 3 d diet diaries which were followed by a personal interview with a trained nutritionist on the fourth day. Quantities of foods were estimated using food models and standard food tables were used to calculate nutrient intake. Foods were grouped into ten sources as described by Rugg-Gunn *et al.* (1993). The mean energy intakes (MJ) in the 2000 study were: 8.5 (1.9) in boys and 7.6 (1.5) in girls; these were lower than the published energy intakes in 1980 and 1990. For all subjects, the percentage energy provided by NMES in 1980, 1990 and 2000 were 16%, 17% and 16%. The relative importance of various sources of NMES has changed considerably over the 20 years, as can be seen from the table. The intake of intrinsic and milk sugars can be obtained by subtraction.

	Non-milk extrinsic sugars			Total sugars		
	1980	1990	2000	1980	1990	2000
	%	%	%	%	%	%
Confectionery	29	33	23	22	26	18
Soft drinks	19	27	38	13	20	29
Table sugar	23	12	6	16	9	4
Biscuits & cakes	11	11	15	11	9	12
Milk	0	0	0	9	8	6
Sweet puddings	9	6	6	11	7	7
Breakfast cereals	2	5	9	2	4	7
Fruit	0	0	0	5	4	5
Syrups & preserves	3	2	1	4	3	1
Other sources	3	4	4	7	9	11
All sources (%)	100	100	100	100	100	100
Mean (SEM) g	83.0 (1.4)	90.3 (1.8)	81.1 (1.5)	117.1 (1.6)	118.3 (2.1)	108.4 (1.7)

Conclusions: (1) Consumption of NMES has remained high in English adolescents over the past 20 years; substantially higher than recommendations (60 g or 10% of energy, maximum); (2) the contribution of soft drinks to NMES intakes has doubled over 20 years to reach 38% (*P*<0.05); (3) the contribution of confectionery increased between 1980 and 1990, but declined between 1990 and 2000; (4) the contribution of table sugar to NMES has decreased (*P*<0.05) while the contribution from breakfast cereals has increased over the past 20 years.

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Feeding practices in children aged 10–18 months of low-income mothers from an urban area of Botswana. By J. EARLAND[1] and B.M. GASETSIWE[2], *[1]School of Health and Social Sciences, Coventry University, Priory Street, Coventry CV1 5FB and [2]Ministry of Health, Gaborone, Botswana*

Over half of the population of Botswana live in urban areas (CSO, 1996). Although it has been suggested that poverty is a determinant of poor nutritional status amongst children in Botswana (Ubomba-Jaswa & Belbase, 1996), there have been no previous studies on dietary habits of young children from low-income families. The aims of this study were to investigate early feeding practices and the prevalence of protein–energy malnutrition (PEM) in a sample of children aged 10–18 months of low-income mothers with an income of less than P800 per month (about £100: 1 Botswana pula = £0.125) from Gaborone. Mothers attending three clinics were interviewed using a pre-tested questionnaire. The areas covered included socio-economic characteristics of the family, early feeding practices and food consumption patterns at the time of the survey. Weights of the children were obtained retrospectively from their under-5 cards, at 2-monthly intervals from birth up to the time of the survey.

Of the 129 children of the families who fulfilled the inclusion criteria (response rate 100%), 55% were girls. The average age of the mothers was 26 years (range 16–45). The majority (77%) were unemployed, although 61% had some secondary education, and 88% were unmarried. All of the children in the sample was breast-fed at some stage although 8% were given either formula or unmodified cow's milk as the first milk. Two common complementary fluids offered before 4 months were water (73%) and formula (31%). Water was given either because the mother felt that her child was thirsty or because her own mother had advised her to. The reasons given by the women for giving formula were that they had to return to work, had insufficient breast milk, the child refused to breast-feed, mother or child was ill, to supplement the breast milk and for convenience. The majority of mothers started weaning between 4 to 6 months, as recommended. The most common first foods offered were sorghum porridge (57%) and commercial baby foods (38%). At the time of the survey, 43% of the sample was being given food three times or less a day and the frequency of feeding did not differ significantly when analysed according to age group. All of the children were consuming traditional porridge made from sorghum or maize, enriched with milk or sugar or both by the majority of mothers. However, good sources of protein and fruit and vegetables were consumed less frequently, with approximately two-thirds of the sample not being offered these groups of foods daily. When asked about sources of information on infant feeding, 71% of mothers reported that they had received information from nursing staff.

At the time of the survey, 12.0% of the sample was less than 2 Z-scores below the NCHS median values for weight-for-age only and only 0.8% were seriously malnourished (less than −3 Z-scores). The longitudinal data indicated that the average growth velocity of the sample was above that of the NCHS standards up to 2 months of age and then began to slow down, falling below the median value at around 6 months of age.

In conclusion, breast-feeding was still common amongst the urban poor in this sample and the majority of mothers relied on traditional weaning foods, with modifications to increase the energy density. However, the frequency of feeding and the consumption of other foods were low. Nursing staff and other health workers need to be aware of the rise in the use of formula milks compared to earlier surveys (Manyeneng *et al.* 1985; Ubomba-Jaswa & Belbase, 1996) and the associated health risks, possible dietary inadequacies and the important role they have in giving nutritional advice to mothers.

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Twenty years of change in the dietary intake and BMI of Northumbrian adolescents. By E.S. FLETCHER, A.J. ADAMSON and A.J. RUGG-GUNN, *Human Nutrition Research Centre, University of Newcastle, Wellcome Laboratories, RVI, Queen Victoria Road, Newcastle upon Tyne NE1 4LP*

Good nutrition in childhood is essential both for healthy growth and development, and for the prevention of adult disease. Adolescence is a period of rapid growth and development and thus a time of increased nutritional needs. Over the past two decades, public health messages have targeted both adults and children promoting lifestyle change, particularly a reduction in fat intake, an increased intake of complex carbohydrates and maintenance of a healthy body weight. The aim of this study was to measure changes in diet and adiposity of young adolescents living in Northumberland at three time points over a period of 20 years; 1980, 1990 and 2000.

Children in Year 7 (aged ~11.5 years) attending the same seven middle schools in 1980, 1990 and 2000 were invited to take part in a dietary survey. About 400 children took part in each survey (~65% of those invited to participate). The same 2x 3 d food diary followed by interview with a trained nutritionist method was used in each survey (Hackett *et al.* 1984; Adamson *et al.* 1992). The interview clarified the information recorded and used food models to facilitate estimation of portion size. Height and weight were measured in each survey and BMI values were calculated. Contemporary standard food tables, with additions, were used to calculate nutrient intake in each survey.

	1980 (n 405)		1990 (n 379)		2000 (n 424)	
	Mean	SE	Mean	SE	Mean	SE
BMI (all children)	18.25	(0.13)	18.60	(0.16)	19.83	(0.17)
% of BMIs >25	2		4		9	
Energy (MJ)	8.57	(0.08)	8.42	(0.10)	7.99	(0.10)
% Energy from fat	39.8	(0.18)	39.7	(0.20)	34.9	(0.18)
% Energy from starch	26.9	(0.18)	26.5	(0.19)	30.4	(0.18)
Southgate fibre (g)	13.5	(0.19)	15.3	(0.22)	15.5	(0.23)
Vitamin C (mg)	37.8	(0.98)	53.8	(1.64)	76.5	(2.08)
Calcium (mg)						
Boys	849.4	(17.37)	754.5	(18.80)	771.6	(16.70)
Girls	749.2	(15.00)	719.3	(15.60)	671.3	(12.09)
Iron (mg)						
Boys	10.1	(0.17)	11.7	(0.24)	10.1	(0.20)
Girls	9.2	(0.14)	11.2	(0.27)	8.7	(0.18)

The effect of survey was statistically significant (P<0.05) for all the above variables.

Mean BMI had increased at each survey and the number of children with BMI≥25 doubled in each 10-year period. Energy intake fell as has been reported in other surveys (Gregory & Lowe, 2000). Between 1980 and 1990, percentage energy derived from fat showed no change but in 2000 had fallen to be in line with recommendations (DoH, 1991). Fibre intakes increased in 1990 and were maintained in 2000. NSP intakes in 1990 and 2000 were 9.2 g and 10.7 g, respectively. Intakes of vitamin C had increased in 1990 and continued to increase in 2000, to almost twice the RNI (40 mg; DoH, 1991). Against these positive changes, calcium and iron intakes fell and are a cause for concern. Calcium intake of boys remained low at 772 mg (RNI 1000 mg) while the calcium intake of girls continued the downward trend detected in 1990, to be well below the RNI of 800 mg. Iron intake, which had increased between 1980 and 1990, fell between 1990 and 2000; mean intakes by girls in 2000 were particularly low at 8.7 mg (RNI 14.8 mg).

Positive changes to the diets of young adolescents have occurred, particularly a fall in percentage energy from fat and an increase in 'fibre' intakes. The increasing incidence of overweight against falling energy intakes and decreasing intakes of calcium and iron indicate that detrimental changes have also occurred in the lifestyle and diet of young adolescents. Action is required to reverse these negative trends while maintaining the positive dietary changes achieved by this age group.

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Body mass index from young adolescence to adulthood: a 20-year follow-up. By A. LAKE, A. CRAIGIE, M. GIBBONS, C. WOOD, A. ADAMSON and A. RUGG-GUNN, *Human Nutrition Research Centre, University of Newcastle, Wellcome Research Laboratories, Royal Victoria, Infirmary, Newcastle upon Tyne NE1 4LP*

The UK is facing an obesity epidemic with reported figures of 17.3% for men and 21.2% for women (Department of Health, 1998). Even in childhood, obesity is a prevalent condition and has been associated with an increased risk of obesity in adulthood (Kolata, 1986). It has been observed that most adult obesity treatment programmes only result in small reductions in weight which are not often maintained (Guo *et al.* 2000). In strategies to reduce obesity incidence it may be more advantageous to identify high-risk individuals at an early age and begin prevention in childhood rather than rely on weight management in adulthood. Previous studies have indicated that BMI in childhood has a stronger effect on adult BMI than birth weight and adult lifestyle factors (Guo *et al.* 2000). It is therefore essential to find out how stable relative adiposity is through the transition from childhood, through adolescence and into adulthood and from what age the onset of adult obesity may be most accurately predicted.

A group of 405 adolescents in Northumberland, initially aged 11–13 years in 1979/80 were followed up in 2000/01 when they were aged 30–32 years. Of these 204 agreed to take part in a follow-up study. This investigation examines 196 subjects (115 female, 81 male) for whom weight and height were obtained in both 1980 and 2000.

The height and weight of each child were measured in 1979 using a sliding headpiece and SECA scale, with jacket and shoes removed: height was measured to the nearest 0.25 cm and weight to the nearest 0.5 kg. The height and weight of these subjects were collected again in 2000, using a portable stadiometer and digital scales, in light indoor clothing and without shoes: height was recorded to the nearest 0.1 cm and weight to the nearest 0.1 kg. BMI was calculated (kg/m^2).

Percentile ranks of BMI 1980 and 2000 defined by quartiles

		Lowest 1 (≤16.4)	2 (16.5–17.7)	3 (17.8–19.6)	Highest 4 (≥19.7)	
				1980 (%)		
2000 (%)	Lowest 1 (≤23.4)	51	27	20	2	100
	2 (23.5–25.7)	25	35	29	12	100
	3 (25.8–29.1)	22	25	25	27	100
	Highest 4 (≥29.2)	2	14	27	57	100
		100	100	100	100	

In 1980, the mean height was 1.48 m and mean weight was 40.0 kg. In 2000, mean height and weight were respectively 1.69 m and 76.6 kg. In 1980, the mean BMI was 18.2 (SD 2.82, 95% CI 17.8–18.6), in 2000 the mean BMI was 26.6 (SD 4.61, 95% CI 25.9–27.2).

The range of BMIs in both 1980 and 2000 were ranked and divided into quartiles. Of the 30–32 year-olds who had been in the lowest quartile as adolescents 51% remained in the lowest quartile as adults with a BMI of below 23.4. Of those that were originally identified in the highest quartile at age 11–12 years, 57% remained in that quartile, with a BMI of >29.1. Similarly, 94% of the young adolescents who were in the highest quartile in 1980 went on to be overweight (BMI >25) as adults, 47% became obese adults (BMI >30). Pearson correlation was used to measure the strength of association between BMI in young adolescence and in adulthood. A highly significant correlation was identified (P<0.001, R +0.532). These data indicate that BMI does track from adolescence to adulthood. The incidence of obesity in children in Britain is a serious and increasing public health problem (Chinn & Rona, 2001). This work indicates that this increasing incidence will follow through to adulthood. Strategies aimed at reducing obesity in childhood could have an important influence on the health of the future adult population.

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The prevalence of obesity among adolescent females in the United Arab Emirates. By H.M. AL-HOURANI[1], C.I.K. HENRY[1], A.O. MUSGAIGER[2] and H.J. LIGHTOWLER[1], [1]*Nutrition and Food Science Group, School of Biological and Molecular Sciences, Oxford Brookes University, Gipsy Lane Campus, Headington, Oxford OX3 0BP and* [2]*Environmental and Biological Programme, Bahrain Centre for Studies and Research, State of Bahrain*

Obesity is considered one of the major public health problems worldwide. Obesity may lead to many health disorders affecting many systems in the human body, such as type 2 diabetes mellitus, hypertension and others, as well as psychological and economic problems.

The problem of obesity in children and adolescents is increasing rapidly in the developing and developed countries. Lack of physical exercise, high food intake and the sedentary life have been associated with this increase. In addition, the rapid change in food habits and socio-economic status in the United Arab Emirates (UAE) may increase the prevalence of obesity. The prevalence of obesity among adolescents in the UAE is not known. Therefore, the aim of this study was to investigate the prevalence of obesity among adolescent females in the UAE.

Schoolgirls aged 10–19 years (n 898) were recruited from five Emirates in the UAE. Body weight and height were measured and BMI calculated (kg/m^2). From BMI, subjects were divided in to two categories: overweight (BMI between ≥85 and <95th percentile) and obese (BMI >95th percentile; Must et al. 1991).
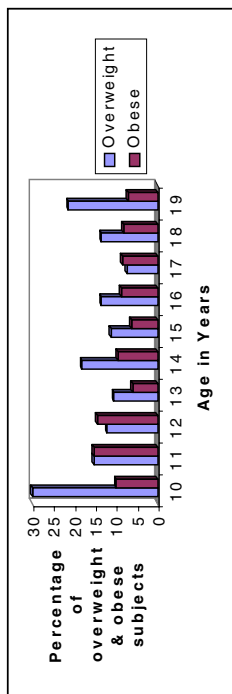
The prevalence of obesity ranged from 6 to 15% and was highest between the ages of 10 and 12 years. The prevalence of overweight was also high at age 10, 14 and 19 years and ranged from 7 to 30%. These results are in agreement with those in the same region (Gulf countries). In Saudi Arabia, the percentage of obesity or overweight was 28% among girls aged 12–19 years (Abahussain et al. 1999); in Kuwait, about one third of the Kuwaiti children aged 14–17 years were overweight (Al-Mousa & Parkash, 2000).

These results indicate that females in the UAE are at high risk of obesity and this problem appears to start at a very early age (pre-adolescence). Further measurements, such as waist and hip circumferences, need to be carried out to ascertain the characteristics of obesity in this community.

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Increasing waist circumferences in British children aged 11–16 years: further evidence for a greater prevalence of childhood overweight and obesity. By S.M. ELLIS and H.D. McCARTHY, *School of Health and Sports Science, University of North London, Holloway Rd, London N7 8DB*

Recent studies have highlighted a dramatic increase in the prevalence of overweight and obesity at various ages in children in Great Britain (e.g. Chinn & Rona, 2001), based upon trends in BMI (kg/m^2). However, the use of BMI in children is not without its drawbacks and any increase in BMI does not indicate whether this reflects changes in fat mass, fat-free mass or both. Furthermore, BMI gives no indication of the distribution of body fat. We have recently proposed that waist circumference measurement could be a suitable alternative or additional indicator of both total and regional adiposity in children and we have developed the first set of waist circumference percentile curves for use in British children (McCarthy et al. 2001). We now report on increases in both BMI and waist circumference measurements in British children between the years 1988 and 1997.

Raw data on weight, stature and waist circumference were obtained for boys and girls aged between 11 and 16 years from the 1988 Body M easurements Survey (boys, n 1562; girls, n 2212; British Standards Institute, 1990) and from the National Diet and Nutrition Survey of Young People Aged 4 to 18 Years (NDNS, boys, n 390; girls, n 390; Gregory et al. 2000). Waist circumference had been measured at the same anatomical site in both studies and was corrected for the NDNS data where measurement was taken over light indoor clothing (Gregory et al. 2000). BMI was derived and means and standard deviations for all variables were calculated and compared between surveys for each year of age using t-tests for independent samples.

Girls were significantly heavier at all ages in the NDNS survey (P ranging between 0.01 and 0.0001) and for boys this was also the case except at age 13 years (P ranging between 0.01 and 0.0001). Stature did not differ in children between surveys except at ages 12 years in girls and at ages 12 and 16 years in boys where the children in the NDNS survey were taller (P ranging between 0.02 and 0.001). As a result, BMI was significantly greater in boys (by 0.82–1.62 kg/m^2, P ranging between 0.04 and 0.0001) and in girls (by 1.0–2.15 kg/m^2, P ranging between 0.015 and 0.0001) in the NDNS survey at all ages compared with BMI in the BSI survey. For waist circumference, measurements were significantly greater in boys in the NDNS survey (between 4.4 and 7.6 cm, P<0.0001 at all ages) and for girls in the same study (between 4.1 and 7.0 cm, P<0.0001 at all ages) compared with those from the BSI survey.

Age	Boys waist circumference (cm) BSI Mean	BSI SD	Boys NDNS Mean	NDNS SD	Girls waist circumference (cm) BSI Mean	BSI SD	Girls NDNS Mean	NDNS SD
11	61.5	6.2	66.9	8.6	59.9	5.7	63.9	4.1
12	64.0	5.9	70.2	8.6	61.6	5.0	68.6	7.0
13	66.4	7.4	70.7	8.2	63.6	5.5	69.5	5.9
14	68.6	6.5	75.5	9.4	64.7	4.8	69.5	4.8
15	70.8	7.2	76.1	8.9	64.9	5.5	70.9	5.9
16	71.9	6.8	79.4	9.9	66.2	5.2	72.4	6.2

These increases in BMI are consistent with the findings of others in this area. However, this is the first study to show that waist measurements in British children have also been increasing over the past 10–12 years. The magnitude of this increase is of great concern as waist circumference is a highly sensitive and specific measure of truncal adiposity in young people (Taylor et al. 2000). Furthermore, waist circumference has been independently associated with unfavourable lipoprotein profiles and insulin levels in children and adolescents (Freedman et al. 1999). At this stage we are unable to explain these increases adequately but are likely to result from changes in physical activity levels and dietary patterns.

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Risk factors for poor iron status in British adolescent girls. By C.W. THANE and C.J. BATES, *MRC Human Nutrition Research, Elsie Widdowson Laboratory, Fulbourn Road, Cambridge CB1 9NL.*

Poor iron status in adolescent children is a major problem due to their higher iron requirements to meet the demands of rapid growth and development. Adolescent girls are at greater risk than boys due to additional losses with the onset of menstruation. The prevalence of iron-deficiency anaemia (IDA) in adolescents is reported to be up to 22% (Nelson *et al.* 1994), while that of iron deficiency (ID) is much higher (up to 40%; Hallberg *et al.* 1993). Non-haematological consequences of ID include loss of appetite, fatigue and reduced activity levels, increased susceptibility to infection, poorer growth, and adverse effects on cognitive function and educational attainment (Nelson, 1996).

Dietary, sociodemographic and lifestyle risk factors for poor iron status were examined in 222 13-to-18 year-old girls from the National Diet and Nutrition Survey of young people aged 4–18 years (Gregory *et al.* 2000). All participants in this analysis provided blood samples and complete 7 d weighed dietary records. Poor iron status was indicated by haemoglobin (Hb) and serum ferritin (SF) concentrations below lower cut-off points of the normal range (Hb <120 g/l, SF <15 µg/l) (World Health Organization, 1972), and low Hb combined with low SF. There was no biochemical evidence of current or recent infection or inflammation (all α_1-antichymotrypsin concentrations <0.65 g/l). Analyses relating food consumption (thirds of distribution for major food groups) to iron status indices also excluded those subjects (5/222) taking iron-containing dietary supplements.

Overall, 8% of adolescent girls had low Hb, 20% had low SF, while 5% had both low Hb and low SF. Low Hb and/or low SF was not associated ($P \geq 0.05$) with region, season, smoking habit, social class of head of household, household income, receipt of state benefits, mother's educational qualifications, dieting, menarcheal status (92% were postmenarcheal) or with use of the contraceptive pill. However, higher percentages of non-Caucasian girls had poor iron status than their Caucasian counterparts, while iron status was also poorer in vegetarians than in meat eaters, as shown in the table.

| | Ethnic group | | | | Meat-eating status | | | |
| | Caucasian | | Non-Caucasian | | Omnivore | | Vegetarian | |
Iron status category	%	Proportion	%	Proportion	%	Proportion	%	Proportion
Low Hb	6[b]	12/199	22	5/23	6[b]	12/197	20	5/25
Low SF	19[a]	36/194	36	8/22	18[a]	35/192	38	9/24
Low Hb & low SF	4[a]	8/192	14	3/22	4[b]	7/190	17	4/24

[a] $P<0.05$, [b] $P<0.01$ (χ^2 test) between categories for each main factor.

Low SF was not associated with consumption levels of the major food groups, although the risk of low Hb (singly and combined with low SF) was significantly greater among non-consumers of fruit juice (13 *v.* 3% and 8 *v.* 2%; $P=0.007$ and 0.04, respectively) and with low consumption of white meat (17 *v.* 3–4% and 13 *v.* 1%; each $P=0.003$). A trend was also found for fewer participants with low Hb (singly and combined with low SF) with increasing consumption of breakfast cereals (both $P=0.07$, Mantel-Haenszel test). Poor iron status, by low Hb and/or low SF, was not associated with dietary total iron intake although low Hb was significantly less prevalent with increasing haem iron intake.

Thus, a high prevalence of poor iron status was found among British adolescent girls. Those from ethnic minority backgrounds (particularly Asians) and vegetarians were at increased risk of ID and/or IDA. Efforts to improve iron status should therefore focus on these two most vulnerable groups.

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An investigation into the relative costs of breast- and bottle-feeding in Liverpool infants up to the age of four months. By K. BERRIDGE, A.F. HACKETT, J. ABAYOMI and S.M. MAXWELL, *Liverpool John Moores University, School of Education, Community and Social Science, IM Marsh Campus, Barkhill Road, Liverpool L17 6BD*

It is generally agreed that breast-feeding is the best method of feeding infants and that only milk is required for the first 4 months of life. Breast-feeding is often claimed to be 'free' but there are few studies of the costs of breast- and bottle-feeding (only one estimate of the cost of bottle-feeding in the UK, £350 per year, Joint Breast Feeding Initiative, reported by Inch, 1994).

A case study approach was used for this initial study. Ten mothers (five breast-feeding and five bottle-feeding) with a child aged either: 1–2, 3–4, 8, 12 or 16 weeks old, living in a less affluent area of Liverpool, were recruited. Each mother was interviewed in detail about how her child was being fed. All items purchased were noted with their cost. The cost of durable items was averaged over 16 weeks. Items reused after a previous child were not taken into account.

Items purchased by the bottle-feeding mothers included: formula, bottles, teats, bottle brushes, sterilizers, bibs, baby wipes, bottle warmers, bottle carriers, electricity, infacol, towels and tissues. Breast-feeding mothers purchased: nursing bras, inflatable pillows, night shirts, breast pads (disposable or washable), breast cream, muslins and breast pumps (hence bottles etc). Several items affecting the cost of breast-feeding were not taken into account; the extra food required (23–29%; Department of Health, 1991) and savings on sanitary items due to cessation of the menstrual cycle (possibly £5 per month). The costs recorded are shown in the table (each row of data was derived from two mothers: one breast-feeding, one bottle-feeding).

| | Breast-feeding cost (£) | | | Bottle-feeding cost (£) | | |
Age of baby (weeks)	Capital outlay	Weekly running cost	Average cost per week	Capital outlay	Weekly running cost	Average cost per week
1–2	108.96	1.75	8.56	119.52	5.70	13.17
3–4	16.28	0.00	3.83	55.84	5.48	8.97
8	40.00	0.00	2.50	64.32	7.35	11.37
12	106.72	0.00	6.67	90.40	7.81	13.46
16	49.12	0.00	3.07	64.96	7.13	11.19
Average	73.28	0.35	4.93*	79.04	6.69	11.63**

*A total of £78.88p/16 weeks; **A total of £186.08p/16 weeks.

Breast-feeding is not free but is substantially cheaper than bottle-feeding. The infant milk market is worth £150 million per year (Mintel, 1998), but the small market for breast-feeding accessories limits the scope for the promotion of breast-feeding by commercial concerns. The initial capital outlay for either form of feeding is considerable; but is higher for mothers intending to breast-feed since they are likely to purchase the necessary items for bottle-feeding in addition. These factors may help explain the low prevalence of breast-feeding, particularly in less affluent areas.

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The relationship between body mass index and indices of psychosocial functioning in children.
By L.C.A. CRAIG[1], J. LOVE[1], G. McNEILL[2] and B. RATCLIFFE[1], [1]*The Robert Gordon University, Aberdeen AB15 4PH* and [2]*University of Aberdeen, Aberdeen AB25 2ZD*

Poor psychosocial functioning is a commonly assumed consequence of obesity; however, studies attempting to quantify this have been inconsistent in their findings. Reviews have indicated that certain groups may be more likely to suffer psychosocial problems as a result of overweight, identifying sex and age as possible demographic risk factors (French *et al.* 1995; Friedman & Brownell, 1995). The aim of this study was to investigate the relationship between BMI and indices of psychosocial functioning in 8–10 year-old children. Sixty-one boys and sixty-eight girls aged 8–10 years were recruited from schools in the Aberdeen area and the dietetic clinic at the Royal Aberdeen Children's Hospital. Children completed three psychological questionnaires assessing self-esteem, depression and incidence of bullying. Body mass index was calculated from measured height and weight. BMI was divided into tertiles for analysis and Mann-Whitney tests were carried out to compare the lowest and highest tertiles.

Minimum and maximum possible scores range from 0–20, 0–36 and 0–12 for self-esteem, depression, and bullying, respectively.

	Self-esteem		Depression		Bullying index	
Tertile of BMI	Median	Interquartile range	Median	Interquartile range	Median	Interquartile range
Boys						
Lowest (n 21)	17	15–19	10[†]	7–13	4	1–7
range 14.0–16.3						
Middle (n 19)	18	15–19	8	4–14	1	0–7
range 16.4–17.4						
Highest (n 21)	17	17–19	8[†]	4–9	4	1–7
range 17.6–24.1						
Girls						
Lowest (n 24)	18[*]	17–19	9	5–13	0.5	0–3
range 14.2–16.2						
Middle (n 21)	17	15–18	8	5–11	2	0–4
range 16.3–17.8						
Highest (n 23)	17[*]	15–18	7	4–12	1	0–3
range 18.0–25.2						

[*]Significant difference between lowest and highest tertile (*P* 0.024); [†]significant difference between lowest and highest tertile (*P* 0.045).

In boys, there was no significant difference between the highest and lowest tertiles of BMI for either self-esteem or reported incidences of bullying. Boys in the highest compared to the lowest tertile of BMI had a significantly lower depression score, indicating fewer reported occurrences of symptoms associated with depression. However, the median scores of depression for all the tertiles were within the normal range. In girls, there was no significant difference between the highest and lowest tertiles of BMI for either depression or reported incidences of bullying. Girls in the highest tertile of BMI had a significantly lower self-esteem score than those in the lowest tertile of BMI, although the difference was relatively small.

A difference between the sexes was seen in the relationship between BMI and indices of psychosocial functioning in this study. Girls with a higher BMI demonstrated lower self-esteem, whereas a higher BMI was not associated with deleterious psychosocial functioning in boys.

French SA, Story M & Perry CL (1995) *Obesity Research* **3**, 479–490.
Friedman MA & Brownell KD (1995) *Psychological Bulletin* **117**, 3–20.

Effect of vagal stimulation on hepatic lipid metabolism.
By M.D. ROBERTSON, A.O. MASON and K.N. FRAYN, *Oxford Centre for Diabetes, Endocrinology and Metabolism, Nuffield Department of Clinical Medicine, University of Oxford, Oxford OX2 6HE*

Postprandial fat tolerance is now recognized as an important indicator of cardiovascular disease risk. Recent evidence suggests that vagal stimulation in combination with an oral fat load impairs postprandial fat tolerance although the relative contributions of endogenous and exogenous lipid remain to be determined (Mattes, 1996). Vagal stimulation was achieved using the 'chew and spit technique' or a modified sham feed (MSF) in which an appetizing modest-fat meal (38 g fat) was tasted but not swallowed. Seven healthy, male subjects consumed a 50 g fat load (Calogen, SHS UK) on three separate occasions; (i) fat load alone, (ii) fat load preceded by 4× 15 min periods of MSF and (iii) fat load followed by 4× 15 min periods of MSF. Blood samples were taken for a total of 7 h.

*P<0.05
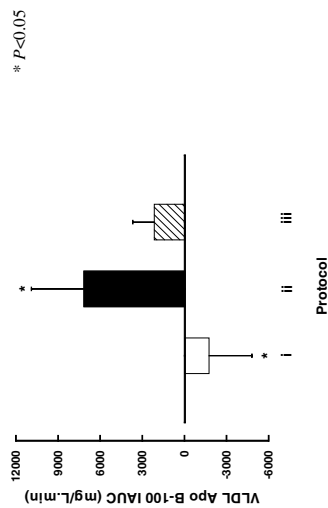
There were significant differences in the postprandial triacylglycerol (TAG) response between the three conditions (*P*<0.001) with higher TAG levels following MSF even though <1 g additional fat had been swallowed (98% recovery of total fatty acids in expectorant by GC). Both MSF studies resulted in significant increases in plasma pancreatic polypeptide concentration compared to the control, indicating increased parasympathetic activity. MSF for 1 h prior to fat ingestion resulted in a significant rise in plasma insulin (*P* 0.013), a more rapid rise in the chylomicron-TAG concentration (*P* 0.04) and significant elevations in both VLDL-TAG and apolipoprotein B-100 levels, quantified by SDS-PAGE. The integrated apo B-100 response is shown above. Vagal stimulation prior to fat ingestion enhances postprandial lipaemia due to effects on both chylomicron and VLDL metabolism although the main effects on TAG appear to be hepatic in origin.

Mattes RD (1996) *American Journal of Clinical Nutrition* **63**, 911–917.

The anti-obesity effects of conjugated linoleic acid in the rat are accounted for by the *trans*-10, *cis*-12 isomer, but are gender-dependent. By M.J. AZAIN[1] and F. CHI[2]. [1]*Animal and Dairy Science Department, University of Georgia, Athens, GA 30602 USA and* [2]*Renessen LLC, 3000 Lakeside Drive, Bannockburn, IL 60015, USA*

Conjugated linoleic acids (CLA) are a mixture of positional and geometric isomers of linoleic acid (*cis*-9, *cis*-12-octadecadienoic acid) formed by rumen and colonic bacteria. The ability of CLA to prevent mammary and other tumours in rodents was first identified in the mid-1980s (reviewed by Pariza *et al.* 2000). In the late-1990s the observation that CLA has anti-obesity effects was made (Park *et al.* 1997). Subsequently, it was determined that the anti-obesity effect in mice can be attributed to the *trans*-10, *cis*-12 isomer (Park *et al.* 1999). We have demonstrated that feeding a mixed CLA (42% each of *c*-9, *t*-11 and *t*-10, *c*-12) reduces adipose tissue mass in growing rats by reducing fat cell size (Azain *et al.* 2000). Our initial objective in conducting this work was to confirm that the *trans*-10, *cis*-12 isomer was also responsible for reducing body fat in the rat. Male Sprague-Dawley rats (initial weight 166 g) were fed semi-purified diets containing linoleic acid, a mixed CLA, or pure isomers for 28 d. The control diet contained 7% soya oil. Mixed CLA was included at 0.4% of the diet. Pure isomers were added at levels that corresponded to the amounts found in the mixed CLA. Despite evidence for incorporation of CLA into adipose tissue, there was no effect of diet on fat pad weights. A second study was conducted in female rats (initial weight 85 g). Mixed CLA reduced fat pad weight 24% after 7 weeks of feeding. The *trans*-10, *cis*-12 isomer accounted for this reduction. There was no effect of the *cis*-9, *trans*-11 isomer on fat pad weights. To confirm the gender differences in response to CLA, a third study was conducted in which weanling male and female rats (*n* 32) were fed control or 0.5% mixed CLA for 8 weeks (data not shown). As in the earlier studies, there was no effect of CLA on growth rate or feed efficiency. Fat pad weights were not affected in the male rats (Control 3.3 g *v.* CLA 3.2 g, NS), but were reduced by 40% in the females (Control, 1.55 *v.* CLA, 0.91 g; *P*<0.05). Collectively, these results indicate that, as in the mouse, the *trans*-10, *cis*-12 isomer of CLA is responsible for reductions in adipose tissue mass but that, unlike the mouse, there are gender differences in responsiveness. Male Sprague-Dawley rats show no reduction in fat mass in response to dietary CLA.

	Diet	Final weight (g) (*n* 10/diet)	Food intake (g/d)	Weight (g)	Retroperitoneal fat pad		
					Tissue *c*-9, *t*-11 CLA (mg)	Tissue *c*-9, *t*-11 CLA (mg)	Tissue *t*-10, *c*-12 CLA (mg)
Expt 1 Male rats	Control	302	18.7	1.21	0.00[a]	0.00[a]	0.00[a]
	Mixed CLA, 0.4%	308	18.7	1.36	1.10[b]	0.60[b]	1.18[c]
	c-9, *t*-11, 0.16%	305	19.1	1.47	1.37[b]	0.47[b]	0.00[a]
	t-10, *c*-12, 0.16%	297	19.6	1.46	0.00[a]	0.03[a]	0.62[b]
Expt 2 Female rats	Control	207	15.3	1.52[a]	0.00[a]	0.00[a]	0.00[a]
	Mixed CLA, 0.4%	217	14.2	1.16[b]	0.60[b]	0.42[b]	0.42[b]
	c-9, *t*-11, 0.16%	204	14.1	1.57[a]	0.47[b]	0.07[a]	0.07[a]
	t-10, *c*-12, 0.16%	199	14.8	0.76[b]	0.03[a]	0.33[b]	0.33[b]

Means with different superscripts within an experiment represent significant effect of diet, *P*<0.05.

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Pariza MW, Park Y & Cook ME (2000) *Proceedings of the Society of Experimental Biology and Medicine* **223**, 8–13.
Park Y, Albright KJ, Liu W, Storkson JM, Cook ME & Pariza MW (1997) *Lipids* **32**, 853–858.
Park Y, Storkson JM, Albright KJ, Lie W & Pariza MW (1999) *Lipids* **34**, 235–241.

Nutrient regulation of gene expression: conjugated linoleic acid, lipid metabolism and energy homeostasis. By H.M. ROCHE[1], E. NOONE[1], A.J. VIDAL-PUIG[2], S. O'RAHILLY[2] and M.J. GIBNEY[1]. [1]*Unit of Nutrition, Department of Clinical Medicine, Trinity Health Sciences Centre, St James's Hospital, Dublin 8, Ireland and* [2]*Department of Clinical Biochemistry and Medicine, Addenbrookes Hospital, Hills Road, University of Cambridge, Cambridge CB2 2QR*

Conjugated linoleic acid (CLA) refers to the positional and geometric conjugated dienoic isomers of linoleic acid (C18:2*n*-6) that are found in the lipid fraction of meat, milk and dairy products. CLA may have the potential to reduce the risk of obesity, diabetes and atherosclerosis. Previous studies have demonstrated that CLA reduces adiposity, improves plasma lipid metabolism, is anti-atherogenic, improves glucose tolerance and insulin resistance. In contrast another study showed that CLA induced a dyslipidaemic, pro-diabetic state. To date, studies have used heterogeneous blends of CLA isomers and there is little information in relation to the metabolic and molecular effects of the individual CLA isomers.

Twenty-four male *Ob/Ob* mice were randomly allocated to receive a diet rich in *cis*-9 *trans*-11 CLA (*c*-9, *t*11-CLA), *trans*-10 *cis*-12 CLA (*t*10, *c*12-CLA) or linoleic acid (control) for 4 weeks. The animals were killed in the fed state. It was found that *c*9, *t*11-CLA significantly reduced plasma triacylglycerol (TAG) (*P*<0.01) and non-esterified fatty acid (NEFA) (*P* 0.05) concentrations. This was associated with a significant downregulation of hepatic sterol regulatory element-binding protein 1c (SREBP-1c) (*P*<0.005) and hepatic tumour necrosis factor (TNFα) (*P*<0.008) mRNA expression. The *t*10, *c*12-CLA diet significantly reduced body weight and adiposity (*P*<0.0001), which was not due to reduced feed intake, increased serum glucose (*P* 0.025) and insulin (*P* 0.01) concentrations. The *t*10, *c*12-CLA diet increased brown and white adipose tissue uncoupling protein (UCP)-2 (*P* .001) and skeletal muscle UCP-3 (*P* 0.008) mRNA expression.

Plasma lipid, glucose and insulin concentrations. Values represent group means ± SD.

	TAG (mmol/l)	NEFA (mmol/l)	Insulin (ng/ml)	Glucose (mmol/l)
Control	1.30 ± 0.21	1.07 ± 0.19	2.05 ± 0.17	14.07 ± 6.54
*c*9, *t*11-CLA	0.95 ± 0.29	0.83 ± 0.65	3.39 ± 0.65	17.15 ± 4.81
*t*10, *c*12-CLA	1.33 ± 0.36	1.03 ± 0.10	15.43 ± 4.42	21.09 ± 4.88

This study highlights the disparate effects of two isomers of the same fatty acids on gene expression, lipid metabolism and energy homeostasis. The ameliorative effect of the *c*9, *t*11-CLA isomer may be mediated by SREBP-1c expression, which regulates the transcription of the genes involved in hepatic fatty acid and TAG synthesis. TNFα promotes the maturation and nuclear accumulation of SREBP-1c in cultured hepatocytes. Therefore we propose that *c*9, *t*11-CLA reduced TAG and NEFA concentrations by reducing TNFα expression, which inhibited SREBP-1c activity, and thereby reduced fatty acid and TAG synthesis. The *t*10, *c*12-CLA isomer had a potent anti-adipogenic effect, which may be explained by increased UCP expression. Nevertheless feeding a diet rich in *t*10, *c*12-CLA induced a profound pro-diabetic state.

Adiposity, plasma lipids and an atherogenic lipoprotein phenotype (ALP). By A.M. MINIHANE, J.A. LOVEGROVE, Y.E. FINNEGAN, S.V. LESAUVAGE and C.M. WILLIAMS, *Hugh Sinclair Unit of Human Nutrition, School of Food Biosciences, University of Reading, Reading RG6 6AP*

Prevalence of overweight and obesity has reached epidemic proportions in the UK, with 50–60% of adult men and women classified in these categories of body weight. Although population-based studies have consistently demonstrated a positive association between excess body fat with a centralized topography and elevated circulating levels of triacylglycerols (TAG), insulin and glucose, and reduced HDL-cholesterol (HDL–C); information on these associations in specific subgroups of the population remains incomplete. The atherogenic lipoprotein phenotype (ALP) is a dyslipidaemia characterized by elevated TAG levels, low HDL–C and a predominance of the putatively atherogenic LDL-3. It has a reported prevalence of 25% in middle-aged males, and is associated with a three-fold increase in coronary heart disease (CHD) risk. In the present study, relationships between body fat and lipoprotein risk factors for CHD are compared in individuals displaying characteristics of an ALP dyslipidaemia relative to non-ALP individuals.

Data were collected from 247 individuals (162M, 85F; mean age 53 years; mean BMI 26.3 kg/m²) who were recruited to participate in studies conducted at the Hugh Sinclair Unit of Human Nutrition. All subjects underwent anthropometric assessment as well as measurement of fasting TAG, total-, HDL-, LDL-cholesterol, and non-esterified fatty acids (NEFA). The relationships between lipid levels and three measures of adiposity (BMI, waist, sum of skinfold thickness) were determined in the group as a whole, and in those predisposed to an ALP (TAG≥1.5 mmol/l, HDL–C≤1.1 mmol/l) relative to the non-ALP subjects (TAG<1.5 mmol/l, HDL–C>1.2 mmol/l).

r	TAG	TC	HDL–C	LDL–C	NEFA
All (n 247)					
BMI	0.43†	0.29†	-0.41†	0.33†	0.12
Waist	0.52†	0.35†	-0.55†	0.41†	0.07
Ssk	-0.01	0.04	0.07	0.05	0.26†
ALP (n 91)					
BMI	0.13	0.01	-0.10	-0.02	0.21
Waist	0.15	0.14	-0.02	0.09	0.25*
Ssk	0.03	-0.04	-0.11	-0.02	0.17
Non–ALP (n 76)					
BMI	0.36†	0.26†	-0.26*	0.29*	0.15
Waist	0.27*	0.23*	-0.33*	0.30*	0.01
Ssk	0.27*	0.19	-0.07	0.19	0.27*

Spearmans correlation analysis, r=correlation coefficients; BMI body mass index, Ssk sum of biceps, triceps, subscapular and suprailiac skinfold measurements; TAG triacylglycerols, TC total cholesterol, HDL–C high density lipoprotein cholesterol, LDL–C low density lipoprotein cholesterol, NEFA non-esterified fatty acids. *P<0.05, †P<0.005.

The expected significant associations between BMI and waist (index of visceral fat) and TAG, TC, HDL–C and LDL–C were observed (P<0.005). However, no significant association between Ssk (index of subcutaneous fat) and these lipid outcomes were evident. Comparable significant associations were observed in the non-ALP subgroup. In contrast, in the ALP group no significant associations between indices of adiposity and lipid levels were evident, with the exception of waist and NEFA (P<0.05)

In conclusion, in agreement with our previous study, total fat mass or body fat distribution is not statistically associated with the ALP dyslipidaemia (Minihane *et al.* 2000). In ALP subjects, factors other than body fat and its distribution are the major determinants of their lipoprotein risk profile for CHD.

Minihane AM, Khan S, Talmud PJ, Williams DL, Wright JW, Murphy MC, Griffin BA & Williams CM (2000) *International Journal of Obesity* **24**, 1097–1106.

Meal fatty acid composition influences the distribution of chylomicron particles in the Sf >400 and Sf 60–400 lipoprotein fractions. By K.G. JACKSON[1], M.D. ROBERSTON[2], B.A. FIELDING[2], K.N. FRAYN[2] and C.M. WILLIAMS[1], [1]*Hugh Sinclair Unit of Human Nutrition, School of Food Biosciences, University of Reading, Reading RG6 6AP* and [2]*Oxford Centre for Diabetes, Endocrinology and Metabolism, University of Oxford, Oxford OX2 6HE*

Although the type of fat given in a test meal has been suggested to influence chylomicron (CM) size through differences in rates of digestion, absorption and incorporation into CM particles (Williams, 1997), few human studies have directly evaluated effects of meal fatty acid composition on the size and density of circulating CM particles.

In the present study, measurement of apolipoprotein (apo) B-48 in the lipoprotein fractions Sf >400 and Sf 60–400 was used to distinguish the presence of large CMs (Sf r >400) and small CMs and CM remnants (Sf 60–400) in the postprandial circulation following meals of different fatty acid composition. Nine postmenopausal women, mean age 57 (sd 5) years and BMI 25 (sd 3) kg/m², were studied on four separate occasions. Following an overnight fast, subjects consumed in random order, a mixed meal containing 40 g of (a) palm oil, (b) safflower oil, (c) a 1:1 mixture of fish oil and safflower oil or (d) olive oil. Blood samples were taken before and for 300 min after the meal when subjects consumed a second meal low in fat (6 g fat). Blood samples were collected for a further 180 min. Lipoprotein fractions were prepared from plasma by density-gradient ultracentrifugation. Triacylglycerol (TAG) was measured by an automated enzymic method and apo B-48 by a specific ELISA.

The incremental AUC (IAUC) for the TAG and apo B-48 responses in the Sf >400 and Sf 60–400 fractions are shown in the table (mean (SE)). Significantly higher apo B-48 IAUCs were observed in the Sf 60–400 than in the Sf >400 fraction following the palm, safflower and olive oil meals, with a similar non-significant trend for fish/safflower oil. The data suggest that for all four oils, the CMs formed were predominantly of the density and size of small CMs and CM remnants (Sf 60–400), rather than of large CMs (Sf >400).

	Palm oil		Safflower oil		Fish/safflower oil		Olive oil	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
TAG IAUC (mmol/l.min)								
Sf >400 fraction	41.0	8	50.5	18	50.4	12	54.2	16
Sf 60-400 fraction	69.9	32	53.1	28	96.4	34	74.6	32
Apo B-48 IAUC (mg/l.min)								
Sf >400 fraction	1.6†	0.2	1.5†	0.7	1.7†	0.5	6.2	1.9
Sf 60-400 fraction	8.0*	2.6	4.2*	1.3	5.2	1.7	11.7†	3.6

Significantly different from the Sf >400 fraction, *P<0.04. Significantly different from olive oil, †P<0.02.

Comparing the responses of the oils in each fraction, olive oil showed a significantly higher apo B-48 IAUC in the Sf >400 fraction (P<0.02), as well as a tendency for higher IAUC in the Sf 60–400 fraction, compared with palm, safflower and fish/safflower oils. Significant differences were not observed in the TAG IAUCs between the oils in either lipoprotein fraction. In conclusion, we have unexpectedly found that the majority of CMs formed following meals comprising either saturated, monounsaturated or polyunsaturated fatty acids are of the density and size of small CMs and CM remnants. Compared with the other oils, the greater apo B-48 responses to olive oil suggest the formation of a greater number of CMs, whilst the TAG data indicate that they are less enriched with TAG. Further studies are required to determine the mechanism(s) whereby monounsaturated fatty acids enhance CM production.

Williams CM (1997) *Proceedings of the Nutrition Society* **56**, 679–692.

Dietary supplementation with pure α-linolenic acid may worsen endothelial function. By N.C. PEGGE[1], R.C. FIELD[1], A.M. TWOMEY[2], I.F.W. McDOWELL[3], M.J. LEWIS[1] and M.W. RAMSEY[2]. *Departments of* [1]*Pharmacology, Therapeutics and Toxicology and* [3]*Medical Biochemistry, University of Wales College of Medicine, Cardiff CF14 4XN and* [2]*Cardiac Centre, Morriston Hospital, Swansea SA6 6NL*

α-Linolenic acid (ALA, C18:3n-3) is a long-chain polyunsaturated fatty acid (PUFA) predominantly derived from plant sources. Chain elongation and desaturation of ALA should yield the marine n-3 PUFA eicosapentaenoic and docosahexaenoic acids. Dietary enrichment with marine n-3 PUFA in hypercholesterolaemic patients improves endothelial function (Goodfellow *et al.* 2000). This study tested the possibility of improving endothelial function in healthy subjects by dietary supplementation with ALA.

After ethical approval, 100 asymptomatic volunteers (fifty male, aged 20–65 years) were recruited from among staff and from friends and non-blood relatives of patients at the two cardiac centres in Wales. Exclusion criteria were pregnancy, diabetes mellitus, hypertension (blood pressure >160/90 mmHg), heart failure, any heart valvular disease; and stroke, myocardial infarction or angina within 3 months. Informed written consent was obtained. Subjects were randomized to 6 months dietary enrichment with two capsules per day of either pure ALA (1 g per capsule) or inert, non-absorbed placebo. Venous blood was drawn for measurement of lipid profiles at randomization and at conclusion. Endothelial function was assessed by recording minute by minute changes in femorotibial arterial pulse wave velocity (PWV) response to reactive hyperaemia (RH). RH was induced by release of an ankle cuff inflated to 250 mmHg for 5 min. PWV variation during RH is known to be endothelium-dependent. The PWV response (V%) was calculated as mean percentage reduction in PWV during the first 5 min of RH compared to baseline PWV.

	Baseline PWV (m/s)		Baseline V%		Post intervention PWV		Post intervention V%	
	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
Active	10.5	0.27	8.2	0.8	9.9	0.2	4.9	0.9
Placebo	10.5	0.29	6.1	1.1	9.7	0.2	6.5	1.1

There were no significant differences in height, weight, blood pressure, endothelial function, PUFA content or fasting lipid profiles between groups at baseline. After 6 months intervention, there was a significant reduction in PWV response in the active group (P<0.001) and this was significantly different from the response to placebo (P 0.037, Mann-Whitney). Neither intervention had any effect on blood pressure, weight or lipid profiles.

Dietary supplementation in asymptomatic volunteers for 6 months with pure ALA appears to have a deleterious effect on femorotibial PWV response to RH, a measure of endothelial function. This result contrasts with the effect of marine n-3 PUFA supplementation on endothelial function in hypercholesterolaemic subjects, and further investigation is required to ascertain the mechanism for this difference.

Goodfellow J, Bellamy MF, Ramsey MW, Jones CJ & Lewis MJ (2000) *Journal of the American College of Cardiology* **35**, 265–270.

Influence of the structure of stearic acid-rich triacylglycerols on postprandial lipaemia and factor VII coagulant activation. By T.A.B. SANDERS[1], S. BERRY[1] and G.J. MILLER[2]. [1]*Nutrition, Food and Health Research Centre, King's College London, Franklin-Wilkins Building, London SE1 9NN and* [2]*MRC Epidemiology and Medical Care Unit, Royal London and Queen Mary Westfield School of Medicine, London EC1M 6BQ*

An intake in excess of 15 g of triacylglycerols (TAG) containing long-chain fatty acids ($\geq$C14) results in alimentary lipaemia. Exaggerated postprandial lipaemia is associated with accelerated atherosclerosis and chylomicron remnants can be atherogenic and increase risk of coronary thrombosis by increasing factor VII coagulant activity (FVII$_c$). Stearic acid is now being widely used in place of *trans*- fatty acids in fats and spreads. Although stearic acid does not influence plasma low-density lipoprotein cholesterol concentrations, it has been alleged to promote thrombosis. Early studies in animals found that an injection of stearic acid induced thrombosis and subsequent studies found that that stearic acid could increase FVII$_c$ *in vitro*. In a previous study (Sanders *et al.* 2000), a randomized stearic acid-rich TAG decreased the postprandial increase in plasma TAG and factor VII activated (FVII$_a$) concentrations compared with an oleate-rich TAG. In a second study (Sanders *et al.* 2001), cocoabutter which is rich in stearate resulted in a similar postprandial increase in serum TAG and plasma FVII$_a$ concentrations compared with an oleate-rich TAG. Cocoabutter consists mainly of symmetrical TAG with most of the stearic acid being present either as 1,3 di-stearyl-oleyl glycerol. We hypothesized that unsymmetrical stearate-rich TAG would lead to a decrease in postprandial lipaemia and factor VII activation. In order to test this hypothesis, the influence of test meals containing 50 g randomized cocoabutter were compared with 50 g unrandomized cocoabutter on postprandial lipaemia and factor VII activation was determined in seventeen healthy male subjects. The test meal consisted of a muffin and a milkshake and the protocol was similar to that previously reported (Sanders *et al.* 2001). The results are shown in the figures below:
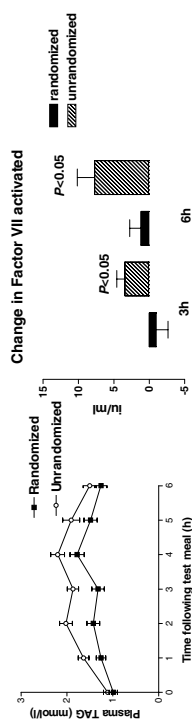
Randomization of the cocoabutter decreased the proportion of symmetrical TAG to approximately 16% from 88% and resulted in an increase in melting point from 35 to 50° without influencing the fatty acid composition of the TAG. The randomized cocoabutter decreased the postprandial increase in plasma TAG (P<0.001) and prevented the postprandial increase in activated FVII concentration (P<0.05 compared with the unrandomized cocoabutter). These findings demonstrate that the structure of stearic-rich TAG determines the metabolic response to stearic acid. Further studies are required to investigate the digestibility of asymmetric stearic-rich TAG and to ascertain whether the 1,3 distearyl-oleyl glycerol structure is conserved upon absorption of unrandomized cocoabutter.

Sanders TAB, de Grassi T, Miller GJ & Morrissey JH (2000) *Atherosclerosis* **149**, 413–420.
Sanders TA, Oakley FR, Cooper JA & Miller GJ (2001) *American Journal of Clinical Nutrition* **73**, 715–721.

The use of factor VII as a biomarker for fat intake in postmenopausal women. By J.M. LAWRENCE[1], B. PARRY[1], R.M. RAINSBURY[1] and B.M. MARGETTS[2], [1]Women's Intervention Nutrition Study (UK), Surgical Unit, Royal Hampshire County Hospital, Winchester SO22 5DG and [2]Institute of Human Nutrition, University of Southampton, Southampton SO16 6YD

Differential under-reporting may partly explain the lack of association between dietary fat intake and breast cancer. The use of a biomarker of fat intake may help reduce this potential bias. Studies have suggested that clotting factor VII is related to total fat intake in women (Mennen et al. 1997) but the effect of habitual fatty acid composition on factor VII is uncertain (Miller, 1998). The Women's Intervention Nutrition Study (UK) investigated the use of factor VII as a biomarker for fat intake during a small feasibility study. Sixteen postmenopausal women with previously diagnosed and treated breast cancer kept a weighed record of their food intake for 7 d. Fasting blood samples were taken on the morning of the eighth day, when the diaries and scales were collected. Mean factor VII for the group of women was 120% (SEM 5.3). Factor VII was analysed using a one stage assay, based on the ability of a test plasma to correct the clotting times of factor VII deficient plasma and therefore measures factor VII coagulant activity. Information from the diaries was analysed using Dietplan 5. Mean values for fat intakes are presented with standard error of the mean. Spearman correlation coefficient was calculated for each of the nutrient intakes with factor VII.

	% Energy from fat	Fat (g/d)	Saturated fat (g/d)	Monounsaturated fat (g/d)	Polyunsaturated fat (g/d)
Mean	35	74	24	19	10
(SEM)	(1.8)	(6.6)	(2.7)	(2.0)	(1.5)
Correlation coefficient	0.13	0.20	0.35	0.24	−0.17
P=	0.625	0.450	0.186	0.375	0.05

No significant correlations were observed between intake and factor VII, indicating that factor VII is not associated with percentage energy from fat, total fat intake, saturated, monounsaturated or polyunsaturated fat intake in this sample of women.

The search for methods of verifying dietary assessment instruments must continue. Studies such as the Women's Intervention Nutrition Study are particularly susceptible to intervention-associated response set bias. However, without studies of this nature, answers to important public health questions will remain elusive.

Mennen LI, Witteman JCM, den Breijen JH, Schouten EG, de Jong PTVM, Hofman A & Grobbee DE (1997) American Journal of Clinical Nutrition **65**, 732–736.
Miller GJ (1998) American Journal of Clinical Nutrition **67**, 542S–545S.

Measuring insulin sensitivity using ^{13}C-glucose and gas chromatography/combustion/isotope ratio mass spectrometry. By A.T. CLAPPERTON and L.J.C. BLUCK, MRC Human Nutrition Research, Elsie Widdowson Laboratory, Fulbourn Road, Cambridge CB1 9NL

Clearance of a glucose load from plasma can be described using the minimal model (Bergman et al. 1979). The aim of the model is to recreate important aspects of the behaviour of the real system using a mathematical structure. It was developed to allow the measurement of glucose kinetics and insulin sensitivity from experimental protocols, such as the Intravenous Glucose Tolerance Test (IVGTT). Subsequently, the IVGTT was improved with the addition of a stable isotope-labelled tracer to the glucose bolus, which not only improves the precision of parameter estimates but also allows the separation of endogenously produced glucose from that of glucose disposal.

To date, the preferred method for the determination of tracer in the plasma has been Gas Chromatography/Mass Spectrometry (GC/MS), which is a comparatively imprecise technique for isotope analysis. This increases the costs of performing such studies as the test requires about 2 g of 6,6-[2]H-glucose to be administered. Gas Chromatography/Combustion/Isotope Ratio Mass Spectrometry (GC/C/IRMS) is a technique that allows specific isotope determinations and offers superior precision. This has two consequences; firstly, by using ^{13}C-glucose in combination with GC/C/IRMS a reduction in the amount of label used would provide a more affordable diagnostic tool, and secondly, the increased precision may reveal previously unobserved nuances in the kinetics which may assist in improving the physiological model.

In order to test the suitability of the combustion technique to replace GC/MS, a comparative study has been performed. Four healthy, non-obese (BMI <27 kg/m^{2}) males were recruited. A modified frequently sampled IVGTT protocol was followed; this involved administering a glucose bolus comprising a combination of unlabelled glucose, 6,6-[2]H-glucose and 1-^{13}C-glucose made up as a 50% dextrose solution. Human insulin was administered after 20 min and in total thirty-two blood samples were taken. Glucose and insulin concentrations were then determined. Isotope measurements were made using the butylboronic acid acetates of plasma glucose, using GC/MS for deuterated glucose analysis and GC/C/IRMS for ^{13}C-glucose analysis, with appropriate correction for material introduced during derivatization. Plasma glucose concentrations were determined using the Beckman Analyzer 2. Plasma insulin concentrations were determined using fluorometric techniques.

When tracer/tracee ratios from the two methods were compared, we found that there was a high degree of correlation. In all four subjects linear regression analysis gave a straight line with a slope representing the different amounts of tracer used, and an intercept not significantly different from 0 (P<0.05). In each case the correlation, r, was greater than 0.93.

	[2]H V [13]C Linear Regression Analysis			
Subject	1	2	3	4
Slope	0.062±0.0045	0.048±0.0027	0.049±0.0035	0.058±0.0029
Intercept	0.0004±0.0002	0.0003±0.0001	0.0003±0.0002	0.0005±0.0001

This has demonstrated the usefulness of the GC/C/IRMS technique for measuring insulin sensitivity in an analogous way to the GC/MS method, but with a considerable reduction in the amount of tracer given. The consequent reduction in costs makes the IVGTT more accessible to clinical investigators.

Bergman RN, Ider YZ, Bowden CR & Cobelli C (1979) American Journal of Physiology **236**, E667–E677.

Whole grain food consumption by British adults from two national dietary surveys. By R. LANG, C.W. THANE, C. BOLTON-SMITH and S.A. JEBB, *MRC Human Nutrition Research, Elsie Widdowson Laboratory, Fulbourn Road, Cambridge CB1 9NL*

Epidemiological evidence shows an inverse relationship between consumption of whole grain foods and the risk of coronary heart disease, cancer and diabetes, with a reduction in risk of approximately 30% in those consuming more than three servings of whole grain foods per day (Jacobs *et al.* 1995; Salmeron *et al.* 1997; Liu *et al.* 1999).

Dietary data from two nationally representative samples were analysed to provide the first assessment of whole grain food consumption in Great Britain. In 1986–7, consumption by adults aged 16–64 years (*n* 2086) was assessed using 7 d weighed dietary records from the Dietary and Nutritional Survey of British Adults (Gregory *et al.* 1990). In 1994–5, 4 d weighed dietary records were assessed for free-living people aged ≥65 years (*n* 1189) from the National Diet and Nutrition Survey of the elderly (Finch *et al.* 1998). From around 5000 food codes, 164 and 80 foods, respectively, were identified as containing ≥51% whole grain ingredient(s) by weight. A serving was identified on each occasion these codes appeared in a dietary record. Proportions of individuals reporting no whole grain food consumption (% NC) and the number of servings per week are shown below by age and sex.

| | | Servings of whole grain foods per week | | | | | | |
		16–24 y	25–34 y	35–44 y	44–54 y	55–64 y	≥65 y
Men	% NC (*n*/total *n*)	49 (84/172)	31 (78/252)	28 (71/254)	31 (57/183)	24[†] (43/180)	34 (209/616)
	Mean (SD)	3 (4)	4 (4)	5 (6)	5 (6)	6 (6)	7 (7)
	Median (IQR)	1 (0–4)	2 (0–6)	3 (0–9)	3 (0–8)	3[*] (1–8)	5 (0–10)
Women	% NC (*n*/total *n*)	40 (62/154)	28 (69/245)	21 (51/244)	27 (59/218)	24[†] (44/184)	33 (189/573)
	Mean (SD)	3 (4)	4 (5)	5 (5)	5 (5)	5 (5)	6 (6)
	Median (IQR)	1 (0–3)	2 (0–6)	3 (1–7)	4 (0–7)	4[*] (1–8)	5 (0–9)

[†]$P<0.001$ for trend aged 16–64 y (χ^2), [*]$P<0.001$ for trend aged 16–64 years (Kruskal-Wallis). NC, non-consumers of whole grain foods; IQR, inter-quartile range.

Around 80% of all servings were whole grain varieties of bread and breakfast cereals, with up to 4% from pasta and rice and the remainder from other sources. In the 1986–7 survey there were no significant differences in whole grain consumption between men and women. In each group the proportion of non-consumers decreased ($P<0.001$) and average consumption increased with age ($P<0.001$). In the 1994–5 elderly survey, the proportion of non-consumers was similar to younger adults, but average consumption of whole grain foods was higher. The effects of age and secular trends cannot be identified independently. The median consumption of whole grain foods for men and women was significantly greater in non-manual *v.* manual groups ($P<0.001$ for all groups except elderly women where $P=0.01$) and in non-smokers *v.* smokers ($P<0.001$). When the analyses were confined to whole grain consumers only the differences between groups were smaller but still significant. In the 1986–7 survey only, there were significant regional differences in consumption of whole grain foods (men, $P=0.013$; women, $P=0.004$), with lowest consumption reported in Scotland and Wales.

The high proportion of non-consumers and low median consumption of whole grain foods suggests that dietary recommendations to promote whole grain foods may be a useful strategy to reduce the risk of a number of chronic diseases.

Finch S, Doyle W, Lowe C, Bates CJ, Prentice A, Smithers G & Clarke PC (1998) *National Diet and Nutrition Survey: People Aged 65 Years and Over. Vol. 1: Report of the Diet and Nutrition Survey.* London: The Stationery Office.
Gregory J, Foster K, Tyler H & Wiseman M (1990) *The Dietary and Nutritional Survey of British Adults.* London: HMSO.
Jacobs DR, Slavin J & Marquart L (1995) *Nutrition and Cancer* **24**, 221–229.
Liu S, Stampfer MJ, Hu FB, Giovannucci E, Rimm E, Manson JE, Hennekens CH & Willett WC (1999) *American Journal of Clinical Nutrition* **70**, 412–419.
Salmeron J, Manson JE, Stampfer MJ, Colditz GA, Wing AL & Willett WC (1997) *Journal of the American Medical Association* **227**, 472–477.

Regional variations in consumer knowledge and purchasing of whole grain foods. By S. SMITH[1], A. SMITH[1], D.P. RICHARDSON[2] and C.J. SEAL[1], *[1]Human Nutrition Research Centre, Department of Biological and Nutritional Sciences, University of Newcastle, Newcastle upon Tyne NE1 7RU and [2]Nestlé UK Ltd, St. George's House, Croydon CR9 1NR*

The health benefits of increased consumption of whole grain products include decreased risk of heart disease, reduced risk of some cancers, lowered incidence of diabetes and improved digestive health (Richardson, 2000). Current dietary guidelines recommend increased consumption of whole grains but intake remains low (Krauss *et al.* 1996). Sources of whole grains in the diet include bread, whole grain breakfast cereals, whole grain pastas and brown rice. Despite attempts at raising the awareness of the health benefits of whole grains, consumption of these products has not increased. There is little information in the literature about whole grains and their use in the UK population. This study, therefore, was designed to investigate regional differences in these parameters in populations in Cheshire and Deeside and in Newcastle upon Tyne.

A self-completion questionnaire consisting of fifteen multi-part questions was used in the study. Questions were a mixture of closed questions and questions requiring expression of opinion or knowledge on a rated scale. Some free-text options were also available. Demographic data on age, gender and income were also collected. The questionnaire was distributed by post in Cheshire and Deeside using a customer database in collaboration with Iceland.co.uk and included a stamped envelope for return. In Newcastle the questionnaire was distributed by internal mail to a 15% random subsample of University of Newcastle employees using an alpha listing sorted by employment category to ensure an equal distribution of subjects from each category. Returned questionnaires were coded and data analysed using SPSS Version 10 (SPSS, IL).

239 questionnaires (47.8% of total sent) were returned from the Cheshire group and 268 from Newcastle (44.7% of total sent). 27.8% of the total number of respondents were aged 35–44 years and 28.2% were aged 45–54 years. Overall, 66.9% of respondents were female, although the proportion of males was greater in the Newcastle group (42.9% compared with 22.2%).

Frequency of consumption	Cheshire		Newcastle upon Tyne	
	Mean	SD	Mean	SD
Breakfast cereal	1.90	1.33	2.45	1.71[a]
White bread	2.23	1.62	2.95	1.75[a]
Wholemeal pasta	4.74	1.31	4.82	1.23
Brown bread	3.29	1.74	3.38	1.71
Brown rice	5.14	1.04	5.12	0.97
Wholemeal bread	3.29	1.69	3.09	1.65

Values are mean scores ± SD, 1 = consume every day, 6 = never consume.
[a]Value significantly different from Cheshire, $P<0.05$.

Respondents in Cheshire consumed breakfast cereals and white bread more frequently than those in Newcastle ($P<0.05$). Consumption of wholemeal pasta and brown rice was low in both areas. Although not statistically significant, the percentage of respondents who ate forms of bread other than white (brown, wholemeal, granary and rye) was higher in Newcastle than in Cheshire. Significantly more respondents ate whole grain breakfast cereals (Shredded Wheat, Weetabix and Cheerios) in the Cheshire area compared with those in the Newcastle area ($P<0.05$). This was reflected in a higher percentage of these respondents claiming they recognised the 'Whole grain symbol' present on some cereal packets (54% *v.* 47%). However, of these only 47% and 67%, respectively, were able to state the correct description of the logo. When asked if they agreed or disagreed with the statements 'Whole grain products may protect against cancer' and 'Whole grain products may protect against heart disease', there was no difference in response between groups amongst those who expressed an opinion but a large number (18–34%) indicated they did not know the answer.

The results suggest that there are regional variations in use of whole grain products, and that use is restricted to breakfast cereals and some breads. There is a common lack of knowledge about the potential health benefits of whole grains which must be addressed if consumption is to increase in line with recommendations.

Krauss RM, Deckelbaum RJ, Ernst N, *et al.* (1996) *Circulation* **94**, 1795–1800.
Richardson DP (2000) *Nutrition Bulletin* **25**, 353–360.

Sugar intake at age 4 and 43 years in the 1946 national birth cohort. By D.C. GREENBERG[1], M.E.J. WADSWORTH[2], A.A. PAUL[1], C.J. PRYNNE[1] and C. BOLTON-SMITH[1], [1]*MRC Human Nutrition Research, Elsie Widdowson Laboratory, Fulbourn Road, Cambridge CB1 9NL and* [2]*MRC National Survey of Health and Development, University College and Royal Free Medical School, 1–19 Torrington Place, London WC1E 6BT*

The relationship of sugar intake to health is often the subject of polarized emotive views. During the post-war years up to 1953, sugar was rationed in order to ensure equal distribution of this highly palatable food constituent. Recommendations for reduced sugar intake, as well as fat, are common, due to sugar's perceived contribution to weight gain, obesity and dental caries. However, it is also recognized that low-sugar intake in westernized populations is often associated with a high fat consumption (Gibney, 1990). As a first step to considering the long-term health effects of high relative sugar consumption in the MRC National Survey of Health and Development: 1946 Birth Cohort (Wadsworth, 1991), sugar intake relative to energy was compared during childhood (age 4 years in 1950) and adulthood (age 43 years in 1989). The aim was to investigate evidence of 'life-time' high or low sugar consumers. Dietary sugar intake was assessed from the diet diaries of 2981 members of the cohort both in 1950 (1 d recall of all meals) and 1989 (2 d recall of all food and drink). These data have recently been coded and analysed (Price *et al.* 1995; Prynne *et al.* 1999).

The analysis tested whether those subjects grouped into the lower or higher fifths of sugar intake (g/d and percentage of energy, %en) at age 4 years reported similarly low or high sugar intakes at age 43 years, using ANOVA. The percentage of subjects in the highest fifth of intake at both time-points and the percentage in the lowest fifth of intake at both time-points were also examined.

| | | | | | Fifths by intake at age 4 years | | | | | | | | |
| | 1 | | 2 | | 3 | | 4 | | 5 | | Total | |
Males	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Sugar (g/d) age 4	31.0	0.4	48.3	0.2	60.6	0.2	73.6	0.2	98.4	0.6	63.3	0.5
age 43	98.8	3.1	99.7	2.9	103.6	3.1	106.8	2.9	107.0	2.6 †	103.6	1.3
Sugar (%en) age 4	9.5	0.1	13.3	0.04	15.9	0.03	18.7	0.04	23.5	0.1	16.3	0.1
age 43	16.6	0.4	16.8	0.4	16.5	0.4	17.5	0.4	17.1	0.3	16.9	0.2
Females												
Sugar (g/d) age 4	31.1	0.4	48.0	0.2	60.3	0.2	73.9	0.2	99.3	0.8	61.5§	0.5
age 43	74.6	2.0	78.7	2.1	80.8	2.0	80.4	2.4	80.4	2.4 *	79.0§	0.9
Sugar (%en) age 4	9.4	0.1	13.3	0.04	16.0	0.03	18.8	0.04	23.9	0.2	16.1	0.1
age 43	17.4	0.4	18.6	0.4	18.3	0.4	19.3	0.5	19.3	0.4 †	18.6§	0.2

Significance of linear trend in ANOVA *$P<0.05$, †$P<0.01$.
Significance of difference between sexes in ANOVA ‡$P<0.05$, §$P<0.001$.

The greater than three-fold difference in sugar intake (g/d) between the fifths in 1950 suggests that sugar rationing did not induce equality of intake in this age group. Whilst this may have been due to different availability, aspects of parental dietary control or differences in sugar preference between children may also be relevant. The %en of sugar in the diets at age 43 years was significantly related to childhood intake for women, but not for men. Women who were in the highest third for %en sugar intake in childhood and in adulthood had lower BMI and energy intakes, and a lower %en fat intake at age 43. They were also more likely to have lived in the south at age 4 and to have fathers in the non-manual occupational social class than those in the lowest third at both ages. There was a similar effect for men, except that men in the highest third of %en sugar intake weighed less, without a difference in daily energy intake.

These subjects will be followed into older age to see if and how their health outcomes differ.

Gibney MJ (1990) *Journal of Human Nutrition and Dietetics* **3**, 245–254.
Price GM, Paul AA, Key FB, Harter AC, Cole TJ, Day KC & Wadsworth MEJ (1995) *Journal of Human Nutrition and Dietetics* **8**, 417–428.
Prynne CJ, Paul AA, Price GM, Day KC, Hilder WS & Wadsworth MEJ (1999) *Public Health Nutrition* **2**, 537–547.
Wadsworth MEJ (1991) *The Imprint of Time.* Oxford: Oxford University Press.

Reliability of web-based dietary recommendations for the prevention of coronary heart disease. By J.K. PEDEN, R.J. MEADE and S. McPHERSON, *Health Informatics Group, London School of Hygiene and Tropical Medicine, London WC1B 3DP*

Today, there is a vast amount of information available on the Internet regarding nutrition and prevention of disease. This availability of information is an important aspect of modern medicine, which, owing to the nature of the Internet, is largely uncontrolled by medical professions. Only a small body of work has begun to address issues surrounding the quality of information on the Internet and these issues have yet to be fully considered in the light of the importance of 'evidence based medicine'. Work on evaluation of websites on specific topics so far has covered only a small range of topics (Abbott, 2000).

The aim of this study was to systematically evaluate the quality of web-based information on dietary recommendations for the prevention of coronary heart disease (CHD) using two search engines and to compare the ability of the two search engines to identify good quality websites.

On 23 March 2001, two search engines, Google and Altavista, were used to search the Internet for sites containing information on coronary heart disease and nutrition using different combinations of search terms. Sites included in the study were subject to a number of inclusion and exclusion criteria. Included sites were then examined in detail and assessed according to a predefined set of criteria. The main outcome measures were content quality (reliability, accuracy, scope and depth, relevance, disclosure of author, disclosure of sponsor, references, currency of information, authority of source) and site aesthetics (accessibility, links, quality of link, user support, graphic appeal, interactivity, ease of use, layout). An evaluation form was devised with a grading system based on a review of published criteria for evaluating health-related websites (Kim *et al.* 1999). The information on CHD and diet was compared to European dietary recommendations for the prevention of heart disease (European Heart Network, 1998). The two search engines were then compared for the quality of the information on the sites that they delivered.

Google delivered a total of thirty-one websites meeting the inclusion criteria and Altavista delivered twenty-four. Seven sites were retrieved on both searches. The quality of the websites was diverse. The overall quality was mediocre, with the mean content quality being 16.1 (minimum 4, maximum 26) for the Google sites and 15.87 (minimum 6, maximum 26) for the Altavista sites (out of 29). The mean aesthetic quality was 10.19 (minimum 3, maximum 17) for the Google sites and 11.13 (minimum 0, maximum 17) for the Altavista sites (out of 20). Further comparisons will include analysis by type of website (Professional, Organization and Commercial) and by the combination of search terms used.

The preliminary results indicate that the current web-based information regarding diet and CHD is lacking in terms of quality of content and aesthetics and that the quality of information accessed by the public will vary depending on the search terms and search engines used. These results highlight the importance of using evidence-based guidelines when assessing the content of health websites.

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European Heart Network (1998) *Food, Nutrition and Cardiovascular Disease Prevention in the European Union: Report Prepared by the European Heart Network's Expert Nutrition Group.* http://www.ehnheart.org [accessed 6/4/01].
Kim P, Eng TR, Deering MJ & Maxfield A (1999) *British Medical Journal* **318**, 647–649.

Critical appraisal of methods used to estimate non-milk extrinsic sugars. By S.A.M. KELLY[1], A.J. RUGG-GUNN[1], C. SUMMERBELL[2] and P.J. MOYNIHAN[1], [1]The Dental School, University of Newcastle, Framlington Place, Newcastle upon Tyne NE2 4BW and [2]School of Health, University of Teesside, Middlesbrough TS1 3BA

A number of studies have reported non-milk extrinsic sugar (NMES) content of foods and contribution to dietary intakes. As part of a critical appraisal of methods for NMES estimation the aims of the present study were (1) to review the methods which have been used, and (2) to compare values for NMES derived by different methods. A comprehensive literature review was carried out using Medline, Embase, Health-CD and HMIC databases. Thirty-two studies were found in which NMES values were reported and five different methods to estimate NMES were identified. No published method provided sufficient information to support replication of any of the methods.

On the basis of level of complexity and application in previous dietary surveys, three methods of NMES estimation were selected to apply to the foods in McCance and Widdowson's 'The Composition of Foods'. Further clarification to enable replication of each method was obtained from authors. The methods were: (1) that used in the National Diet and Nutrition Surveys (e.g. Gregory et al. 1995; NDNS1, described as 'all sugars in fruit juices, table sugar, honey, sucrose, glucose and glucose syrups added to food plus 50% of the sugars in canned, stewed, dried or preserved fruits); (2) that used in the Dietary and Nutritional Survey of British Adults (Mills, 1994; MAFF2, described as 'NMES intakes estimated from total sugars by deducting the sugars from liquid cows milk'); (3) that used by the Human Nutrition Research Centre, Newcastle University (Rugg-Gunn et al. 1993; HNRC3, described as 'added sugars plus sugars from fruit in fruit juices and other soft drinks').

The NMES values for all foods in McCance and Widdowson's 'The Composition of Foods' (5th edn) were calculated (g/100 g) using each of the three methods. Food groups known to contribute substantially to NMES intake were selected and the values for NMES content of foods were compared between methods using paired t-test. In order to illustrate differences between methods for NMES estimation (i.e. relative over/under estimate) mean NMES content of all foods in each food group were determined. Results are tabulated below.

| Food group | n | NDNS1 | | MAFF2 | | HNRC3 | | P | | |
		Mean g/100 g	SD	Mean g/100 g	SD	Mean g/100 g	SD	NDNS1 v. MAFF2	NDNS1 v. HNRC3	MAFF2 v. HNRC3
Biscuits	16	20.7	14.5	24.2	17.0	22.2	15.5	0.039	0.073	0.032
Cakes	15	34.4	8.0	39.3	8.9	34.7	9.1	0.005	0.707	0.013
Confectionery	20	57.2	20.0	60.4	19.3	60.4	19.5	0.001	0.001	0.330
Breakfast cereals	28	17.4	14.9	20.9	15.7	17.6	16.4	0.000	0.808	0.005
Sugar/syrup/preserves	15	65.2	24.3	69.2	21.2	59.6	29.4	0.056	0.161	0.025
Ice-creams	11	17.8	8.2	22.6	8.4	17.7	8.4	0.000	0.518	0.000
Yoghurts	14	2.9	4.2	8.9	5.6	2.9	4.2	0.000	1.000	0.000
Fruit juices	7	7.7	3.9	7.7	3.9	7.7	3.9	1.000	1.000	1.000

The MAFF2 method tended to give higher values. The only significant difference between NDNS1 and HNRC3 was for confectionery, for which NDNS1 gave lower values.

Thus, the method of NMES estimation is likely to affect the calculated NMES content of dietary intake and the reported contribution of food groups to total NMES intakes. There is a clear need for one standardized approach for the estimation of NMES in foods and for the full details of the method to be published to allow accurate replication.

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Relationship between rate of starch digestion and endosperm hardness of wheat cultivar samples. By V.R. PIRGOZLIEV[1], S.P. ROSE[1], P.S. KETTLEWELL[2] and L.A. TUCKER[3], [1]National Institute of Poultry Husbandry and Crop and [2]Environment Research Centre, Harper Adams University College, Newport, Shropshire TF10 8NB and [3]Finnfeeds International Ltd, Marlborough SN8 1AA

Rose et al. (2001) have shown that wheat samples with hard endosperm gave better chicken growth performance compared to soft wheat samples. Waldron (1997) found a positive relationship between in vitro rate of starch digestion (RSD) of wheat and its feeding quality for poultry and also found a positive correlation between rate of starch digestion and endosperm hardness. The rate of in vivo starch digestion is difficult to determine in poultry because of the large amounts of gastrointestinal reflux so an in vitro technique gives a more precise method of determining hydrolysis rates. The objective of the present study was to examine the relationship between the rate of starch digestion and the endosperm hardness in twelve UK wheat samples from two different harvest years (1993 and 1996).

Two sets of six wheat cultivar samples were grown at Harper Adams College in 1993 (Beaver, Brigadier, Dean, Rialto, Haven, Riband) and in 1996 (Beaver, Brigadier, Dynamo, Hussar, Hunter, Riband). The samples were produced from replicated blocked wheat growth experiments. After harvest the wheat samples were placed in a dry grain store. The endosperm hardness (EH) of each wheat sample was determined in relative percentage units from 1 to 100 (soft – hard) by a near infra-red spectroscopy technique (Oxford Instruments, Oxford) that detected particle size after grinding in a standard mill. One soft wheat sample was used as a zero calibration point. The in vitro rate of starch digestion was determined following the laboratory techniques developed by Englyst et al. (1992). The procedure used physical damage and enzymatic hydrolysis of the wheat samples and the amount of glucose that was released by starch hydrolysis was determined after 10, 25, 40, 60 and 120 min. The rate constant (c) for starch digestion was determined using an exponential rate curve ($y = a(1 - e^{-ct})$). The rate of digestion measurement was replicated three times for each of the twelve wheat samples.

There was a significant relationship between the RSD and the EH within each of the harvest year wheat samples (r^2 0.54; $P<0.05$), although the wheat samples from the 1993 harvest had a higher endosperm hardness ($P<0.05$) than the 1996 samples. An increase of each unit of EH gave an increase of 0.014 g/100 g/min in RSD.
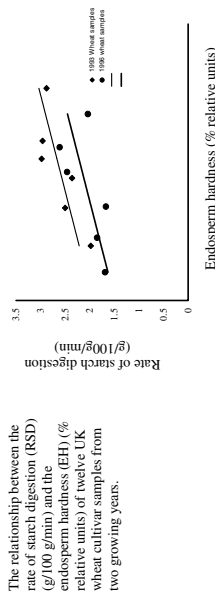
The relationship between the rate of starch digestion (RSD) (g/100 g/min) and the endosperm hardness (EH) (% relative units) of twelve UK wheat cultivar samples from two growing years.

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Wheat endosperm hardness is an important characteristic in the quality of wheat for bread making (Sulaiman et al. 1993). Hard endosperm wheats shatter when milled and the flour is fine, with regular particle sizes and these physical characteristics would appear to be important in giving a more rapid rate of starch hydrolysis within the digestive tract. Commercial broiler chickens have eating patterns that give a continuous supply of food to the crop and the small intestine. A faster rate of starch digestion could result in improved growth performance because a greater proportion of starch would be hydrolysed in the proximal jejunum and would avoid microbial fermentation in the distal parts of the digestive tract.

Effect of feeding wheat straw upgraded by edible mushroom *Pleurotus florida* to sheep, on ruminal bacteria, protozoa and *in vivo* digestibility. By O. MONTANEZ, M.E. ORTEGA-CERRILLA, M. COBOS, C. BECERRIL, J.E. GARCIA and A. LARQUE, *Colegio de Postgraduados, Carr. México-Texcoco km 35.5, 56230 Montecillo, Edo. de México, México and Universidad Agraria Antonio Narro, Saltillo, Coahuila, México*

Different studies have shown that feeding agricultural byproducts such as roughages and straws upgraded by edible mushrooms to ruminants increases feed intake and productive performance (Calzada *et al.* 1987; Henicz, 1987). However, some products formed during lignin degradation may limit the activity of ruminal bacteria (Jung & Fahey, 1983; Akin *et al.* 1993). Therefore the objective of this study was to investigate the effect of feeding wheat straw upgraded by *Pleurotus florida* to sheep on ruminal concentration of total and cellulolytic bacteria, and protozoa, pH, acetic, propionic and butyric acids, ammonia nitrogen and digestibility of dry matter (DMD), crude protein (CPD), neutral detergent fibre (NDFD), acid detergent fibre (ADFD), hemicellulose (HD) and cellulose (CD). Eight male 'Criollo' lambs weighing 32 (SD 7.22) kg fitted with rumen fistula, were housed in individual pens and randomly assigned to untreated wheat straw (US; four animals) or wheat straw upgraded by *P. florida* (TS; four animals). Lambs were fed on a ration containing 700 g/kg of US or TS together with 300 g/kg of a compound feed (670 g ground maize, 170 g ground sorghum, 100 g molasses, 50 g soyabean meal, 5 g mineral premix, 5 g salt). Animals had an adaptation period of 15 d, then feed was adjusted to 90% for 5 d and finally faeces were collected during the following 8d. During the last 2 d of the experiment rumen fluid was collected. Data were analysed by *F* test.

	US	TS	SE
Total ruminal bacteria/ml	0.30×10^{10a}	1.83×10^{10b}	0.27
Cellulolytic bacteria/ml	2.48×10^{7}	2.13×10^{7}	0.75
Protozoa/ml	5.26×10^{5}	7.46×10^{5}	0.90
pH	6.45	6.62	0.16
Ammonia nitrogen (mg/dl)	2.03	1.58	0.78
Acetic acid (mmol/l)	16.63	12.20	1.19
Propionic acid (mmol/l)	4.93	4.07	2.00
Butyric acid (mmol/l)	3.45	4.85	2.45
DMD	0.64	0.67	0.04
CPD	0.53	0.43	0.04
NDFD	0.52	0.56	0.05
ADFD	0.51	0.53	0.06
HD	0.52	0.64	0.04
CD	0.56	0.62	0.04

[a,b]Values with different superscript were significantly different *P*<0.05.

Total ruminal bacteria was higher (*P*<0.05) for the TS, which might be due to the higher concentration of nitrogen in TS (1.36%) compared with US (0.53%), which could favour an increment of total bacteria (Wallace & Cotta, 1988). However, cellulolytic bacteria, rumen protozoa, pH, ammonia nitrogen and volatile fatty acids were not affected by the growth of *P. florida* on the straw. Digestibility of DM, CP, NDF, ADF, H, C was not affected either. These results indicate that metabolites produced by lignin degradation did not affect rumen environment and nutrient digestibility by feeding wheat straw upgraded by *P. florida*.

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Wallace RJ & Cotta MA (1988) In *The Rumen Microbial Ecosystem*, pp. 217–249 [PN Hobson, editor]. London: Elsevier Applied Science.

Effect of two strains of *Saccharomyces cerevisiae* on productive performance of heifers. By U. CORONEL, M.E. ORTEGA-CERRILLA, G. MENDOZA, M.T. SANCHEZ, J. AYALA and C. BECERRIL, *Colegio de Postgraduados, Carr. México-Texcoco km 35.5, 56230 Montecillo, México and Universidad Autónoma Chapingo, Carr. México-Texcoco km 36.5, 56230, Chapingo, México*

Heifers must have an adequate weight in order to be bred at 14–15 months of age (Hoffman, 1997). Therefore the feed offered to these animals should contain sufficient nutrients for the animal to achieve optimal growth. Feed additives such as *Saccharomyces cerevisiae* have been fed to ruminants to increase their productive performance (Williams & Newbold, 1990). The present study evaluated the effect of two strains of *S. cerevisiae* on daily feed intake (FI), body weight gain (BWG), and digestibility of dry matter (DMD), neutral detergent fibre (NDFD), acid detergent fibre (ADFD) and nitrogen (ND), when fed to growing heifers from 6 to 12 months of age. Twenty-four Holstein heifers, body weight 151.42 (SD 19.30) kg were housed in individual pens and randomly assigned to T1 (control treatment), T2 (10 g/d per heifer Levucell SC2; no. 5008, 20×10^{9} colony forming units (CFU/g) or T3 (10 g/d per heifer Levucell SB2; no. 5005, 20×10^{9} CFU/g). Heifers were fed a diet containing roughage and concentrated feed in a ratio of 58.78:41.22, respectively (g/kg: nitrogen 36.2, neutral detergent fibre 432.7, acid detergent fibre 271.0). Feed intake was recorded daily, heifers were weighed every 2 weeks. Digestibility was evaluated when animals were 8, 10 and 12 months old. Chromic oxide (2 g Cr_2O_3/animal per day) were given for the last 14 d of each 60 d period. Faeces were collected during the last 4 d. Data were analysed using a spli t-plot design with repeated measurements over a period of time.

						Fortnight						
	1	2	3	4	5	6	7	8	9	10	11	12
						FI (kg/d)						
T1	5.72	7.42	7.40	7.51	7.50	8.15	9.99	10.21	9.18	9.94	11.37	11.78
T2	5.81	6.78	7.38	8.61	8.10	9.02	10.24	10.26	10.38	10.99	11.66	11.13
T3	6.61	6.74	7.57	8.43	8.33	8.93	10.08	10.57	11.19	10.93	10.53	10.66
SE = 1.91												
						BWG (kg/d)						
T1	1.06	0.96	0.92	0.77	0.72	0.83	1.34	1.21	1.16	1.09	1.08	1.09
T2	1.09	0.73	0.90	0.94	0.86	1.10	1.26	1.20	1.10	0.94	0.98	1.03
T3	0.88	0.88	0.70	1.05	1.14	1.05	1.05	1.07	1.05	0.81	0.78	0.71
SE = 0.14												

Age (months)	DMD			NDFD			ADFD			ND		
	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
8	0.73	0.79	0.75	0.70	0.74	0.73	0.64	0.70	0.64	0.81	0.85	0.78
10	0.79	0.81	0.79	0.75	0.77	0.75	0.70	0.72	0.70	0.82	0.85	0.84
12	0.80	0.80	0.76	0.76	0.76	0.71	0.64	0.72	0.71	0.83	0.83	0.82
	SE = 0.19			SE = 0.24			SE = 0.41			SE = 0.15		

The addition of *S. cerevisiae* did not improve (*P*<0.05) FI, BWG, FC, DMD, NDFD, ADFD or ND. There are indications that the effectiveness of *S. cerevisiae* seems to be affected by the diet and nutritional demands of the host, age of the animals, level of intake, level of addition of the yeast and culture media where the yeast was grown (Newbold *et al.* 1995). Unfortunately in this study, although the diet fed to the animals met their requirements (NRC, 1988), and the level of addition of *S. cerevisiae* was adequate for animals of that age, no beneficial effects were observed on the productive performance of the heifers, which suggests that higher levels of *S. cerevisiae* need to be investigated in these animals.

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What do itemized supermarket receipts reveal about the fat and energy content of the food shopping of households comprising overweight and obese members? By J.K. RANSLEY[1], J.K. DONNELLY[1], H. BOTHAM[1], T.N. KHARA[1], H. ARNOT[1], J.E. CADE[2] and D.C. GREENWOOD[2], [1]The Public Health Nutrition Unit, Trinity and All Saints, University of Leeds, Brownberrie Lane, Horsforth, Leeds LS18 5HD and [2]Division of Public Health, Nuffield Institute for Health, The University of Leeds, 71–74 Clarendon Road, Leeds LS2 9PL

Recent figures suggest that over half of the adult population is overweight and 18% of men and 20% of women can be classified as obese (Comptroller and Auditor General, 2001). Supermarkets are now the major supplier of domestic food in the UK diet and as such may be considered a major route by which fat and energy enter the diet of households. They may also play an important role in shaping the family diet by designing meal solutions that fit into a faster, more fragmented style of family eating (Euromonitor, 2000).

Food from the supermarket enters the household via the primary shopper or gatekeeper(s). The food the gatekeeper(s) choose to buy and serve at home may be an important determinant of familial dietary patterns. Investigating possible links between diet, food purchased and the tendency for household members to be overweight may provide insights into factors that may predispose to obesity and help to inform effective dietary interventions designed to prevent or manage obesity.

A sample of 214 households, who spent an average of 90% of their food purse in supermarkets, were recruited from a random sample of Tesco Clubcard members in Leeds. Itemized supermarket receipts were collected for a period of 28 d to estimate household food purchased from supermarkets and other retail outlets (Ransley et al. 2001). Self-reported height and weights were used to calculate BMI. A mean household BMI of ≥25 was used to classify households as 'overweight' and <25 as 'lean'.

	Lean households (n 129)	Overweight households (n 85)	P value
Percentage energy from fat in food purchased from:			
Supermarkets (SD)	34.8 (6.9)	37.6 (6.9)	0.004
All outlets (SD)	34.8 (6.6)	37.7 (6.5)	0.002
Mean daily purchase of fat (g) per person from:			
Supermarkets (SD)	71 (29)	90 (33)	0.001
All outlets (SD)	77 (30)	101 (37)	0.001
Mean daily purchase of energy (MJ) per person from:			
Supermarkets (SD)	7.58 (2.26)	8.81 (2.38)	0.001
All outlets (SD)	8.23 (2.34)	9.89 (2.65)	0.001

The table shows significant differences between the mean daily fat and energy content of food purchased from supermarkets by the overweight households. In addition, there were significant differences between the fat and energy of total food purchases for domestic consumption by overweight households. Multiple logistic regression showed that after controlling for age, social class, household size and spend on food, each of the variables in the table had a significant predictive effect on household obesity.

Supermarket receipts indicate a significant difference between the fat and energy purchasing behaviour of households that contain overweight/obese members compared to those containing predominantly lean members.

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Food shopping experiences in older people living in Guildford: preliminary findings. By L.C. WILSON, A. ALEXANDER and M. LUMBERS, School of Management Studies for the Service Sector, University of Surrey, Guildford GU2 7XH

It is predicted that there will be 11.9 million people aged over 65 years in the UK by 2021 (Office of National Statistics, 2000). Between 1995 and 2025 the number of people over the age of 80 is set to increase by almost a half and the number of people over 90 will double. These changes in population will necessitate a corresponding adaptation of the food retail sector to meet the specific consumer demands and requirements of this fast growing sector.

The relationship between nutrition and health has long been recognized, especially in maintaining the independence of older people (Finch et al. 1998). However, research has shown that a healthy diet may not be easily accessible for disadvantaged groups, including some older people (Social Exclusion Unit, 1998). The nature of retailing has changed over the last 20 years with the growth of large 'out of town' supermarkets and the closure of community-based shops. Currently only 10% of older people living alone have access to a car. Many older people are therefore reliant on local shops which have been found to be up to 60% more expensive and have a limited choice of foods. Food choice research shows that those older people who experience the greatest difficulties in food shopping are at greatest nutritional risk. Recent research has demonstrated differences in stated beliefs and actual consumption patterns with access, cost and quality of food compromising eating practices (McKie et al. 1999). The present study reports some initial findings regarding the experience of food shopping among older people living in Guildford and attending local day centres. It forms part of a larger study examining the effect of food retail store location on access, food choice and diet in older people.

A series of small-scale focus group interviews were conducted to determine views on a number of key issues regarding choice of shop, transport, access and social networks associated with food shopping. Interviews were recorded and transcripts analysed using a method described by Burnard (1991). Five main categories were identified by respondents as being central to their shopping experience. These included: access to the shop; access within the shop; choice and price of food items and the use of social networks. Mobility and access were reported to be fundamental to maintaining independence. Coping strategies included shopping with friends or relatives, which also increased the opportunity for social interaction. Respondents emphasized the importance of 'getting out', spending time with friends or relatives with 35% stating that they relied on these individuals for taking them shopping. They reported that food shopping facilitated their need to be part of an active society. Respondents reported difficulty in getting to food shops, which they stated was made harder by the changing retail landscape and geography of Guildford town centre. Respondents mentioned the lack of supermarkets in the town centre and many were frustrated by recent developments, which they felt had not taken into account the needs of older people. Thirty percent of respondents felt that their lack of choice in where they shopped. Attitudes to access varied but their lack of mobility was a defining factor for most people. Inside the store, cafeterias were reported to be desirable for resting or socializing. Problems in-store included the height of shelves that were either too high or too low for easy access. Several respondents reported that smaller packages did not give value for money. Although supermarkets were cheaper and offered a wider range of items, the quality of foods was poorer than local traditional shops. Quality was strongly linked to value for money. Respondents did not object to paying more for quality. They felt this was both acceptable and necessary. The ability to be able to shop and choose foods for themselves was a fundamental issue for many respondents. It also formed a source of pleasure with regard to food shopping. Respondents emphasized that doing their own shopping was important in maintaining a level of control over their food choices. However, some respondents felt they had little choice over where they shopped. Several had to think of the best way to get what they needed and often shopped more than twice a week. The degree to which these issues affect the maintenance of a healthy diet will be explored in further studies, with specific reference to determining how food choices affect diet in older people.

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Weight loss on a sugar-containing energy restricted diet: a three-centre study. By S. DRUMMOND[1], C. DIXON[2], J. GRIFFIN[3] and A. DE LOOY[1] [1]*Centre for Nutrition and Food Research, Queen Margaret University College, Edinburgh EH12 8TS, [2]Birmingham Heartlands Hospital, Bordesley Green East, Birmingham B9 5SS and [3]11 Loveday Road, Ealing, London W13 9JT*

Current figures for Scotland and England indicate that the prevalence of overweight and obesity is continuing to rise in both men and women (Department of Health, 1997; The Scottish Executive Health Department, 2000). The search for an effective weight-reducing strategy is of paramount importance in terms of reducing obesity levels and related health risks. Current dietary recommendations include advice to reduce the proportion of fat and increase the proportion of carbohydrate, in particular starch, in the diet (Department of Health, 1994). Although studies have indicated that increasing the ratio of CHO:fat can promote weight loss (Kirk, 2000), a diet high in starch, low in sugar and low in fat can be bulky and unpalatable. Another method of increasing the CHO content of the diet is to include a proportion of sugary foods. A recent study compared compliance with two low-fat diets, one with and one without sucrose (Drummond & Kirk, 1999). Results indicated better compliance and a small 'spontaneous' weight loss with the latter diet over a 6-month period. Therefore the aim of the present study was to investigate the efficacy of an energy-restricted diet, which includes sucrose, on weight loss in overweight men.

Seventy-six overweight sedentary men, recruited from London, Edinburgh and Birmingham, followed an energy-restricted, sucrose-containing diet for a period of 12 weeks. Compliance to the diet was assessed in terms of reported energy and macronutrient intake (by 4 d unweighed food diaries) and body weight status.

	Baseline (n 76)	SE	12 weeks (n 76)	SE
Dietary intakes				
Energy intake (MJ)	10.43	0.35	7.21*	0.24
% Food energy fat	38.1	0.68	26.2*	1.15
% Food energy CHO	44.4	0.71	54.0*	1.23
% Food energy starch	26.9	0.61	30.7*	0.85
% Food energy NME sugar	9.5	0.53	10.7*	0.73
Anthropometry				
Body weight (kg)	106	2.00	100.5*	1.90
BMI (kg/m²)	34.6	0.60	32.8*	0.54
% Body fat	31.2	0.59	27.7*	0.55
Waist:hip	1.00	0.01	0.97*	0.01

*Significantly different from baseline values (paired sample *t*-test, P<0.05).

Dietary changes at 12 weeks included a reduction in energy intake (3.22 MJ/d), an increase in percentage energy from CHO (by 21.6%), and a reduction in percentage energy from fat (by 31.2%). As a result, an almost 2-fold increase in the CHO:fat ratio was seen after 12 weeks – from 1.17 at baseline (44:38.1%) to 2.06 after 12 weeks (54/26.2%), indicating a high degree of compliance with the dietary advice. The increase in CHO was achieved by increasing the proportion of both starch and sugar. Reduction in body weight over this 12-week period represented a weight loss of 5.2%. Percentage body fat significantly decreased by 11%, from 31.2% to 27.7%, with a small but significant reduction in waist:hip ratio, indicating reduced health risks (SIGN, 1996).

Contrary to popular opinion, it may not be necessary to restrict sugar in a weight-reducing diet to promote weight loss. Moreover, the inclusion of sugary foods may have a role to play in achieving the recommendation for dietary fat reduction and in increasing the palatability of a low fat diet.

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The Scottish Executive Health Department (2000) *The Scottish Health Survey 1998.* Edinburgh: HM Stationery Office.

Prevalence of malnutrition in people aged 65 years and over in Great Britain. By R.L. THOMPSON, B.M. MARGETTS and A.A. JACKSON, *Institute of Human Nutrition, University of Southampton, Southampton SO16 6YD*

Undernourished individuals are at greater risk of illness, have poorer recovery from illness and a poorer quality of life (Elia, 2000). The Malnutrition Advisory Group (MAG) has recently developed guidelines for the detection and management of under-nutrition in the community (Elia, 2000). The aim of this report is to measure the prevalence of under-nutrition using the MAG tool in a representative sample of older people in Great Britain. The National Diet and Nutrition Survey of people aged 65 years and over (Finch *et al.* 1998) includes data on both free-living and institutionalized people. Using a modification of the MAG tool, subjects were classified into risk groups based upon their measured body mass index (BMI) and reported weight loss in the last 6 months. Subjects were classified as high risk if BMI <18.5 kg/m², or BMI 18.5–20.0 kg/m² plus weight loss of 3.2 kg or more, or BMI >20.0 kg/m² plus weight loss of more than 6.4 kg. Medium risk was classified as BMI 18.5–20.0 kg/m² plus weight loss of <3.2 kg or weight gain (unless no long-term illness and no weight loss when classified as low risk), or BMI >20.0 kg/m² and weight loss 3.2–6.4 kg. Low risk was classified as BMI >20 kg/m² and no weight loss.

Of an initial eligible sample of 2172, 1368 subjects provided anthropometric data. Using a modification of the MAG tool, 95 (6.9%) subjects were classified as high risk and 91 (6.7%) as medium risk of malnutrition. The prevalence of medium or high risk of malnutrition was 11.8% for men and 15.4% for women and 12.1% in free-living subjects and 20.8% for those in institutions. There was an increasing trend by age group (10.2% for 65–74 years, 14.8% for 75–84 years and 16.8% for 85 years and over). In subjects living in Northern England and Scotland, risk of malnutrition was 9.0% compared with 10.6% for those in Central, South West England and Wales, and 13.1 % for those in London and the South East. The prevalence was 27.7% for those who reported bad or very bad health status, 16.6% for fair and 10.7 for reported good or very good health. Having a long-standing illness (16.5% compared with 6.6%) and being in hospital in the last year (20.0 compared with 11.9) increased the risk of malnutrition. Logistic regression was used to determine the key factors associated with malnutrition and analysis was carried out for men and women separately using the above variables. For men the odds ratios (95% confidence interval) for risk of malnutrition were 2.2 (1.2–3.9) for institution versus free-living, 2.3 (1.2–4.6) for long-standing illness (yes *v.* no), 2.6 (1.3–5.3) for being aged 85 years and over compared with 65–74 years, 2.8 (1.5–5.1) for living in Northern England and Scotland compared with London and South-East and 1.8 (1.1–3.2) for being in hospital in the last year (yes *v.* no). For women, the odds ratios were 3.0 (1.6–5.6) for long-standing illness (yes *v.* no) and 2.8 (1.3–6.4) for reported health status (bad compared with good).

These data suggest that malnutrition is a problem in the older population and is associated with reported poorer health and long-term illness. The problem is particularly important in institutions where at least one in five residents is classified as being at medium or high risk of malnutrition. Using the MAG tool to screen older people may be an effective approach to detect malnutrition.

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Primiparous women's reported preconception and first trimester folic acid use. By Z.M. BROOKE and W. DOYLE, *Institute of Brain Chemistry and Human Nutrition, University of North London, 166–220 Holloway Road, London N7 8DB*

Optimal folate status, both preconceptionally and during early pregnancy, is recognized as being important in the prevention of neural tube defects (MRC Vitamin Study Research Group, 1991). In the UK, women who could become pregnant or who are planning pregnancy are advised to increase their consumption of folate-rich foods and to take a 400 µg folic acid supplement daily before and during the first 12 weeks of pregnancy (Department of Health, 1992).

Previous work in Hackney has identified a strong association between social class, nutrient intake and birth weight (Wynn et al. 1994). This study was undertaken to examine the effects of maternal nutritional status in the first trimester of pregnancy on pregnancy outcome in women who are expecting their first baby. One hundred primiparous women were recruited from the Homerton hospital in East London. Participants completed a short researcher-led questionnaire. The woman's current occupation was used as a proxy measure of socio-economic status. Gestation was obtained from the ultrasound scan report.

The mean gestation at booking was 11 weeks and 3 d. Eighty-three women (83%) reported taking folic acid, of whom thirty-one (31%) reported taking folic acid preconceptionally. The reported duration of supplementation ranged from 1 week to 18 months, the median duration of preconceptionally or once they had become pregnant. The majority of these women were not Caucasian (n 11) and were unwaged (n 14). Women who did not take folic acid supplements were significantly younger than the women who did (P<0.05).

Women in non-manual occupations were significantly older, than the other women (unwaged women P 0.001; manual workers P<0.005). Significantly more women in non-manual occupations reported taking preconception folic acid than women in the other groups (both P<0.05). Unwaged women were less likely to report taking folic acid during the first trimester (P<0.001). Caucasian women were significantly more likely to report taking folic acid both before and during their pregnancy than non-Caucasian women (P<0.05). Women aged 18–25 years were less likely to report preconception folic acid consumption than women aged 31 years and over (P<0.05). Women in the 18–25 age group were also less likely to report taking folic acid during the first trimester than their older counterparts (P<0.05).

Despite an extensive nation-wide awareness campaign, a high proportion of women in Hackney do not take folic acid supplements. Our results are similar to those reported by the HEA (1998) and Mathews et al. (1998). Women at most socio-economic disadvantage, in particular unwaged women under 25 years-old of non-Caucasian origin, appear to be least likely to take folic acid supplements either preconceptionally or during the first trimester of pregnancy.

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Comparison of a diet quiz with a weighed food intake to evaluate dietary practices of post-myocardial infarction patients. By C.R. HANKEY, T. LAPPA, W.S. LESLIE and M.E.J. LEAN, *University of Glasgow Department of Human Nutrition, Glasgow G31 2ER*

When providing dietary advice, health professionals require tools and resources to maximize the effectiveness of their consultations, in particular to facilitate effective dietary assessment. A short, (11-item) quiz to assess dietary intake was designed by Greater Glasgow Health Board (1987) and modified by the Heath Education Board for Scotland. The quiz examines key dietary targets (Scottish Dietary Targets, Scottish Office Department of Health, 1996) including fat, carbohydrate, fruit and vegetable consumption. This dietary assessment and health promotion tool has been widely used but not formally compared to other more rigorous methods of dietary assessment.

A preliminary evaluation of this diet quiz was carried out within cardiac rehabilitation in thirty survivors (twenty-four male, six female) of myocardial infarction. Mean BMI 26.8 (SD 3.0), range 19.9–32.6 kg/m². Dietary intake, prior to the provision of dietary advice, was assessed by both the diet quiz and 7 d weighed intake. Key dietary targets were used to compare the ability of the both methods to classify subjects into tertiles of consumption (low, medium and high) and Bland & Altman analysis was carried out in order to compare the methods (Bland & Altman, 1986).

Individuals (n 30) classified by quiz and 7 d weighed record into the same or different tertiles:

Food group	Same third	Adjacent third	Opposite third
Breakfast cereal	21	7	2
Fruit & vegetables	16	9	5
Total fat (% energy)	20	10	0
Total CHO (% energy)	20	10	0

Few subjects in each group were misclassified into opposite tertiles. Bland & Altman (1986) analysis showed little bias between the methods for percentage energy from fat (7 d weighed record – Diet quiz 0.003, 95% CI –0.246, 0.252), carbohydrate (7 d weighed record – Diet quiz 0.233, 95% CI –0.087, 0.554), portions of breakfast cereals (7 d weighed record – Diet quiz –0.267, 95% CI –1.019, 0.486) and fruit and vegetables (7 d weighed record – Diet quiz 0.333, 95% CI –0.892, 1.566).

The ability of the quiz to correctly classify individuals into high, medium and low consumers was reasonable in terms of key dietary targets between the two methods. This self-administered diet quiz is easy and quick to complete and the present results suggest that the continued use of the quiz in health promotion and dietary assessment is justified.

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Accuracy of lunch recall in children aged 5–7 years. By J. WARREN, C.J.K. HENRY, S. BRADSHAW and S. PERWAIZ, *Nutrition and Food Science Group, School of Biological and Molecular Sciences, Oxford Brookes University, Gipsy Lane Campus, Headington, Oxford OX3 0BP*

Diet survey work is fraught with potential errors and pitfalls that are compounded in children whose developmental and cognitive skills are still evolving. It has been suggested that children from the age of 8 years onwards may be able to provide some dietary information, for example through a 24-h recall (Livingstone & Robson, 2000). Prior to this age, caregivers must provide dietary information.

This study aimed to determine whether children aged 5–7 years were able to provide a reliable report of a lunch eaten at school which may be used as part of a 24-h recall obtained by a parent and/or carer. Portion size estimation was not addressed in this investigation.

Children were recruited from three state primary schools in Oxford and were part of a wider health promotion intervention study. Observations of the midday meals of 203 children aged 5–7 years were made and all foods offered, eaten and left over were recorded in a similar way to that of Domel *et al.* (1994). Foods were classified as a main dish, savoury snack/fried accompaniment, savoury accompaniment, vegetable, fruit, sweet food or drink.
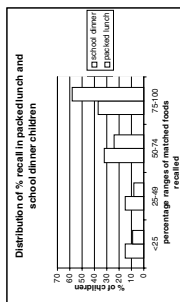
Within 2 h of finishing lunch, children were interviewed using a free recall and then non-directive prompts were employed. Foods recalled were classified as matches (observed and reported eaten), omissions (observed but not reported eaten) or phantoms (not observed but reported eaten), as described by Domel Baxter *et al.* (1999).

Packed lunches were eaten by 65% of the children and school dinners by 35% of the children. There was a higher percentage of matches recalled from children who ate a packed lunch than from those who ate a school dinner.

Distribution of % recall in packed lunch and school dinner children

The best remembered foods after free recall were the main dish and drink for packed lunch children and the fried accompaniment and main dish for school dinner children. Vegetables were one of the least well remembered foods for all children. Phantom foods, foods recalled but not observed eaten, were reported by 22% packed lunch children and 11% school lunch children.

The findings from this study indicate that children aged 5–7 years may be able to provide a reasonable recall of their school lunch which may then be used with a parental 24-h recall as a dietary assessment method. However, given the range of percentage recalls it is likely that the data would be useful at a group level rather than on an individual basis. The use of prompts after a free recall may improve outcomes and needs to be investigated. Further research is also needed to determine the influence of food preference on recall and the ability of children aged 5–7 years to provide portion size estimations.

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Nutritional influences on indices of bone health: preliminary results from the 'extent of osteoporosis in young British women' study. By L. PORTEOUS[1], J. CATTERICK[1], J.A. BISHOP[1], L.E. CROSSLEY[1], D.J. PATTISON[2], A.D. WOOLF[2], P. TAYLOR[3], C. COOPER[3] and S.A. NEW[1], [1]*Centre for Nutrition and Food Safety, School of Biomedical and Life Sciences, University of Surrey, Guildford GU2 7XH,* [2]*Duke of Cornwall Rheumatology Unit, Royal Cornwall Hospital, Truro, Cornwall TR1 3LJ and* [3]*Osteoporosis Centre, University of Southampton SO16 6YD*

Maximum attainment of peak bone mass (PBM) and reduction of postmenopausal bone loss are considered the two most effective ways of reducing the risk of osteoporotic fracture in later life. The exact timing of PBM attainment remains to be fully clarified but studies indicate it occurs around the age of 30 years. This provides individuals with a 'window of opportunity' to improve bone health through environmental factors including physical activity and nutrition. As an important exogenous factor, dietary data in women approaching the latter end of PBM attainment are required.

A multi-centred study is currently under way to investigate the extent of osteoporosis in young British women (Catterick *et al.* 2001; Jaggers *et al.* 2001). One of the objectives of this project is to clarify the association between dietary and lifestyle risk factors and indices of bone health in a representative sample of 300 women aged 20–30 years. The study also provided an important opportunity to collect data, allowing comparison of newer methodologies (such as Quantitative Ultrasound [QUS]) with the more traditional approaches (e.g. dual X-ray absorptiometry [DXA]). A total of 106 women were recruited randomly from GP practices in different socio-economic areas of Surrey. Dietary intake was assessed using 7 d estimated food diaries; bone mineral density (BMD) was measured using DXA at lumbar spine (LS), femoral neck (FN) and whole body (WB) sites and bone 'quality' (ultrasound [BUA] and velocity of sound [VOS]) was measured at the calcaneum using QUS. Information on lifestyle factors was collected using a questionnaire. Preliminary results are presented for seventy-two women.

	Mean	SD		Intake (/d)	Mean	SD		Intake (/d)	Mean	SD
Age (years)	25.7	2.5		Energy (MJ)	8.5	1.6		Iron (mg)	12.1	3.4
Weight (kg)	64.6	11.0		EI:BMR	1.44	0.25		Vitamin C (mg)	114.0	66.7
Height (m)	1.64	0.06		Fat (g)	77.0	19.7		Sodium (mg)	2955	783
LSBMD (g/cm²)	1.029	0.111		NSP (g)	13.8	4.8		Potassium (mg)	3010	712
FNBMD (g/cm²)	0.896	0.114		Calcium (mg)	798	276		Phosphorus (mg)	1230	285

The dietary diaries were of a good standard and generally intakes of micronutrients were similar to the RNI, although there were several exceptions, including K and Mg. Strong correlations were found between both BUA and VOS and the three BMD sites measured (r 0.5, $P<0.001$). Consistent correlations were observed between BUA and B vitamins; thiamin, folate, vitamin B_6 and vitamin B_{12} (r 0.25, $P<0.05$); association between thiamin and BMD (lumbar spine and whole body) was also found. Intakes of fruit and vegetables as well as vegetables alone were positively associated with BUA (r 0.4, $P<0.02$). All remained significant after adjustment of confounding factors including weight, height and energy intake.

Further analysis of the study population is required. Investigation into the degree of specificity and sensitivity of DXA and QUS in this age group will be useful, as well as a more detailed examination of the interesting dietary and bone health associations reported.

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7-day food intake in an Oxfordshire residential home for the elderly. By J.H HOLLIS and C.J.K HENRY, *Nutrition and Food Science Group, School of Biological and Molecular Sciences, Oxford Brookes University, Gipsy Lane Campus, Headington, Oxford OX3 OBP*

Census data from the United Kingdom indicate an aging population. Currently there are 7.75 million adults aged 60–74 years and a further 4.4 million aged 75+. Over the next 20 years these figures are predicted to increase markedly; the 60–74 group numbering 10.5 million and the 75+ group reaching 5.3 million. Significantly, 5% of the elderly population reside permanently in institutions. This figure is certain to rise with the increasingly aging population. Aging is often associated with poor dietary intake and an impairment of health and nutritional status (de Jong et al. 2000). Studies have shown that the elderly diet tends to be low in energy, vitamin D, magnesium, copper, zinc, calcium, iron and folate (Finch et al. 1998). This has been ascribed to poor food intake or lack of variety. Low food intake may be instrumental in the onset of disease and leads to a higher risk of hospitalization (Mowe & Bohmer, 1996).

Thirteen females (mean age 85±7) and seven males (mean age 82±9), who were in good health, were recruited for this study from a local residential care home. Food intake was measured at all meals served in the dining hall on seven different days. Meals were weighed to the nearest 0.1 g prior to serving and after termination of eating. The amount consumed was determined by difference and the nutritional composition of the meal estimated using Diet5 (Robert Gordon University, Aberdeen). Student t-test statistics were used to establish significant differences between sexes and nutrient intake. The table contains the results obtained and compares them with values from the National Diet and Nutrition Survey (NDNS; Finch et al. 1998) and RNI (reference nutrient intake; DoH, 1991).

Sex	n	Age	E (KJ)	Fat (g)	Protein (g)	Thiam. (mg)	Ribof. (mg)	Niacin (mg)	Folate (µg)	Vit. C (mg)	Vit. A (µg)	Ca (mg)	Fe (mg)	B12 (µg)
Mean F	13	85	4132	43.3	32.6	0.6	0.8	13.5	109.5	29.3	425.6	492.1	5.0	2.0
SD		7	800	8.8	8.2	0.2	0.3	3.8	41.3	17.5	83.9	124.7	1.7	0.8
NDNS			6760	65.5	56.7	1.1	1.6	23.3	197.0	49.6	962.0	861.0	8.2	4.6
%ref. Val.			61		58	52	49	58	56	62	44	57	61	44
RNI				66	46.5	0.4	1.1	6.6	200	40	600	700	8.7	1.5
%ref. Val.			70.2		70.2	148.8	72.2	204.0	54.7	73.3	70.9	70.3	57.5	135.6
Mean M	7	82	4792*	49	39.7	0.7	1.0	16.5	131.6	22.0	508.2	572.6	5.9	2.4
SD		9	647	7	4.3	0.2	0.3	2.9	36.4	4.34	81.1	97.1	1.1	0.5
NDNS			7980	76.9	66.5	1.3	1.8	27.3	235	49.6	1054	953	9.6	4.9
%ref. Val.			60		54	55	61	56	60	48	50	61	50
RNI			60	64	53.5	0.4	1.3	6.6	200	40	700	700	8.7	1.5
%ref. Val.			74.2		74.2	180.1	76.8	250.4	65.8	55.0	72.6	81.8	67.5	162.7

Elderly nutrient intake and comparison with NDNS and RNI; *$P<0.05$.

Significant differences ($P<0.05$) were found between the sexes for energy, protein and vitamin A intake. These results also indicate that the nutrient intakes in this cohort were 39–56% lower than the figures reported by the NDNS for the institutionalized elderly. More significantly, nutrient intakes were below the reference nutrient intake for this age group (DoH, 1991). It is concluded that the consumption of catered foods alone is insufficient to meet the subjects' requirements. Supplementary foods from families or residents leaving the home to purchase food may be necessary to meet nutritional needs.

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Biscuits, cakes and confectionery: associations with micronutrient inadequacy among older people. By S. GIBSON[1] and J. LAMBERT[2], *[1]1 Woodway, Guildford GU1 2TF and [2]5 Britwell Road, Watlington OX49 5JS*

Older people are potentially at risk of low micronutrient intakes and status, because food intakes normally decline with age, while micronutrient requirements mostly remain the same or may even increase. It has been suggested that high intakes of sugars and sugar-containing foods may compromise micronutrient intakes by blunting appetite for more nutrient-rich foods. We examined evidence for low micronutrient intakes and status among men and women in NDNS of People aged 65 years and over (Finch et al. 1998). Men and women were classified into four groups (Q1 to Q4) based on the proportion of energy derived from biscuits, cakes and confectionery (BCC). Means in Q1 to Q4 are given below.

Among women, mean calcium and iron intakes were below the Reference Nutrient Intake (RNI) but did not differ according to the proportion of BCC in the diet. Mean folate intakes fell below the RNI for women in Q4, while the prevalence of very low intakes (<LRNI) increased with rising consumption of BCC among men ($P<0.03$, P 0.08 for women). In both sexes, vitamin B6 intake declined significantly with increasing consumption of biscuits, cakes and confectionery, but remained above the RNI. For other micronutrients, there was no evidence of an inverse relationship with consumption of BCC. Indeed, men who were low consumers of BCC had the lowest intakes of several nutrients, including calcium, iron and riboflavin.

Ferritin levels were lowest in Q4. However, there was no difference between groups in the prevalence of anaemia, low iron saturation or ferritin levels below 12 µg/l. There were no associations with status levels for folate, while riboflavin status was more likely to be inadequate among (male) low consumers of BCC, consistent with the intake data.

The relationship between consumption of these snack foods and micronutrient intakes in this population is complex. Intakes of most nutrients appear to be optimal at average levels of BCC, corresponding to about 9–15% of dietary energy. Above and below this normal range, energy intake and other dietary choices (especially consumption of tea, meat, milk and breakfast cereals) help to explain the patterns of nutrient intake and status found in this analysis.

	Men BCC Quartiles (% energy from BCC)					Women BCC Quartiles (% energy from BCC)				
	1 (2%)	2 (9%)	3 (15%)	4 (25%)	P	1 (2%)	2 (9%)	3 (15%)	4 (25%)	P
% of adults below LRNI										
Calcium	9	5	1	4	0.021	11	11	10	9	ns
Iron	1	1	1	1	ns	7	4	5	7	ns
Riboflavin (B2)	9	3	3	5	0.044	9	8	12	13	ns
Pyridoxine (B6)	0	0	0	0	–	0	0	1	0	ns
Folate	0	1	1	3	0.027	5	5	7	9	ns (0.08)
Vitamin C	4	1	1	1	ns	1	2	2	4	ns
% with low status:										
Haemoglobin <130 g/l	12	16	14	9	ns	13	11	8	11	ns
Ferritin <12 µg/l	2	4	7	5	ns	8	11	6	11	ns
Ferritin <20 µg/l	6	5	8	12	0.044	14	18	13	22	ns
Transferrin sat. <15%	10	6	13	5	ns	14	21	10	20	ns
Riboflavin (EGRAC >1.3)	48	38	36	30	0.006	39	32	44	40	ns
Serum folate <7 nmol/l	21	17	15	22	ns	15	16	15	16	ns
Red cell folate <230 nmol/l	4	11	13	10	ns	10	9	8	7	ns
Vitamin C <11 µmol/l	21	15	13	15	ns	16	13	15	13	ns
Vitamin D <25 nmol/l	9	6	5	5	ns	6	16	13	17	ns

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Investigation into the effects of casein and whey protein on circulating metabolite and hormone status and appetite. By W.L. HALL, D.J. MILLWARD and L.M. MORGAN, *Centre for Nutrition and Food Safety, School of Biomedical and Life Sciences, University of Surrey, Guildford GU2 7XH*

Protein is more satiating than carbohydrate or fat (Barkeling *et al.* 1990), and there is some evidence to suggest that different protein sources may vary in their satiating capacity (Uhe *et al.* 1992). A whey protein liquid meal reduced short-term food intake to a greater extent than the same meal containing casein (Long *et al.* 2000), possibly due to coagulation of casein in the stomach leading to delayed gastric emptying and a slower rate of amino acid absorption. It was hypothesized that these proteins exert differing effects on short-term metabolite and hormonal responses. Since whey is more satiating than casein, the response of satiety gut peptides, glucagon-like peptide-1 (GLP-1) and cholecystokinin (CCK) was investigated. A randomized, single-blind, within-subject experimental design was used to examine the effect of casein and whey liquid test meals on plasma glucose, amino acids, insulin, GLP-1, CCK and glucose-dependent insulinotropic polypeptide (GIP) profiles.

Nine lean healthy volunteers (eight females, one male; age 22–30 years; BMI <25 kg/m^2) were studied on two occasions (one for each protein type). Only subjects scoring in the normal range for the Dutch Eating Behaviour Questionnaire, and reporting <20 % of habitual energy intake as protein (7 d food intake diary), were accepted onto the study. They were instructed to avoid alcohol, paracetamol and high-protein meals on days preceding the study sessions. A low-energy standard breakfast was consumed before 08.00 hours. At t 11.30 hours the isoenergetic liquid test meals were consumed, providing 1700 kJ with 48 g protein as casein or whey. Maltodextrin and double cream were added, giving a final ratio for percentage energy of 50:25:25 protein:carbohydrate:fat. The meals also contained 1.5 g paracetamol, which was included as a measure of gastric emptying. Ninety minutes after the casein or whey liquid test meals, subjects were offered a cold lunch, calculated to provide 42 kJ per kg body weight. Venous blood samples were taken at intervals before and after the test meals for 180 min in order to measure plasma paracetamol, metabolite and hormone concentrations. Hunger, desire to eat and fullness ratings were assessed with 100 mm visual analogue scales (VAS).

	Total amino acids (mmol/l. h)		Glucose (mmol/l. h)		Insulin (pmol/l. h)		CCK (pmol/l. h)		GLP-1 (pmol/l. h)		GIP (pmol/l. h)	
	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
Casein	3.4	0.4	2.3	0.6	534.5	85.2	5.9	1.2	56.1	13.8	442.5	68.4
Whey	4.3*	0.4	2.1	0.8	590.1	109.1	9.4***	1.5	92.4*	10.4	603.1**	72.4

Mean 3 h incremental area under the curve (AUC) for plasma metabolites and gut/pancreatic hormones following isoenergetic casein or whey test meals (1700 kJ). Significant differences: * $P<0.05$, ** $P<0.01$, *** $P<0.005$.

Plasma concentrations of total amino acids, CCK, GLP-1 and GIP were significantly increased following the whey liquid test meal compared to casein. Two-way repeated measures ANOVA showed a significant treatment × time interaction ($P<0.05$) for paracetamol, reflecting the differing gastric emptying profiles. There were no differences in incremental AUC for plasma glucose or insulin concentrations. Consuming the whey test meal reduced subjective ratings of desire to eat following the standard lunch ($P<0.05$) and increased overall fullness ($P<0.05$) compared to the casein test meal.

In conclusion, casein and whey differ in their effects on plasma amino acid, CCK, GLP-1 and GIP levels and subjective ratings of appetite. The results are consistent with previous findings that casein and whey meals empty from the stomach at different rates. The greater satiating capacity of whey protein may be due to an aminostatic satiety mechanism triggered by a greater postprandial flux in plasma amino acids, and/or increased satiety gut hormone (CCK and GLP-1) secretion.

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The effect on iron of changing to a self-selected vegetarian diet. By F. ROBINSON, D. BILLINGTON, G. STRATTON and A. HACKETT, *IM Marsh Campus, Liverpool John Moores University, Liverpool L17 6BD*

Meat and meat products provide substantial amounts of iron in the diet. Studies have shown that when these are excluded, intakes of iron are at least similar to and often higher than those of meat-eaters (Taber & Cook, 1980; Alexander *et al.* 1994). Conversely, UK vegetarians have been shown to be more prone to Fe deficiency anaemia because of low iron stores, but haemoglobin concentrations are not consistently different (Reddy & Sanders, 1990; Nathan *et al.* 1996). Most comparisons between vegetarians and omnivores reflect the outcome of interactions between many factors in addition to diet and there have been few studies of the effect of changing to a vegetarian diet. Previous work has shown that after following a prescribed vegetarian diet for 8 weeks, none of the measured blood-iron indices were affected, despite a 6-fold difference in dietary iron availability (Hunt & Roughead, 1999), but a prescribed diet was constructed to ensure adequacy.

We studied the effects on iron intake and blood-iron indices when thirty-three subjects (mean age 31 years; 8 males) who had decided to stop eating meat changed to a self-selected vegetarian diet for 6 months. A vegetarian diet was defined as one which does not include meat or meat products but may include fish, dairy products and eggs. Volunteers who were following a prescribed diet were not included. Dietary intake was measured by 3 d estimated diary and analysed using Microdiet (University of Salford) at baseline (omnivore) and 6 months post-dietary change (vegetarian). Intake excluded dietary supplements. Whole-blood haemoglobin was estimated using a calibrated Haemocue and serum transferrin was measured using a Technicon immunoassay kit.

	Omnivore		Vegetarian	
	Mean	SD	Mean	SD
Dietary variables				
Energy (MJ/d)	8.88	1.942	8.14*	1.895
Fe (mg/d)	12.7	5.35	12.0	5.01
Fe/MJ	1.43	0.552	1.48	0.490
NSP/MJ	1.57	0.719	1.98*	0.470
NSP (g/d)	14.0	7.30	16.0	4.91
Vitamin C (mg)	63.3	46.40	83.2**	36.36
Non-dietary variables				
Haemoglobin (g/dl)	13.4	1.28	13.4	1.336
Transferrin (g/l)	3.85	1.156	3.77	1.001

*Significantly different from omnivore; * $P<0.05$. ** $P<0.01$.

After 6 months on a self-selected vegetarian diet there was no fall in iron intake or in haemoglobin, nor rise in transferrin, indicating no impairment of iron status. This was despite losing all the iron from meat, much in the haem form, and an appreciable rise in intake of NSP. The large rise in intake of vitamin C may have improved the availability of the non-haem iron consumed.

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A comparison of fish eaters with other meat eaters and vegetarians taking part in the UK Women's Cohort Study. By J.E. CADE[1], V.J. BURLEY[1] and D.C. GREENWOOD[1], *Nutrition Epidemiology Group, Nuffield Institute for Health, 71–75 Clarendon Road, Leeds LS2 9PL*

Recent epidemiological observations suggest that good health is associated with a dietary pattern in which fish is consumed on a regular basis (Menotti *et al.* 1999; Williams *et al.* 2000). The UK Women's Cohort Study is a large national cohort study designed to investigate the relationship between dietary patterns and cancer risk. Between 1995 and 1998, 35 372 women aged 35-69 years completed at baseline a 217-item food frequency questionnaire. Subjects were categorized according to frequency of intake of meat and fish into meat eaters, fish eaters and vegetarians. The meat eaters were those consuming meat or meat dishes once per week or more. Fish-eaters were further sub-divided, with oily fish eaters eating oily fish at least 2–4 times per week. Vegetarians were categorized as eating meat or fish less than once per week. Dietary and lifestyle characteristics of these groups of women are described.

	Oily fish eaters (n 870)	Fish eaters (n 3286)	Vegetarians (n 6478)	Meat eaters (n 24 738)
Age (years)	50.8	50.3	48.7	53.6
BMI (kg/m³)	23.2	23.3	23.3	24.9
% smoking daily	5.6	6.8	6.9	8.8
% drinking alcohol >1/week	51.6	54.5	45.4	53.6
% mainly using full fat milk	5.6	9.5	9.7	13.3
% using supplements	72.8	66.6	62.3	54.9
Energy intake (kJ/d)	10853	9966	9761	10088
Fat intake (g/d)	91	85	83	88
Fibre intake (g/d)	31	28	28	24
Vitamin C intake (mg/d)	206	175	176	163
Vitamin E intake (mg/d)	10	9	9	8

For each characteristic, the difference between the four groups was statistically significant (ANOVA, $P<0.001$).

The fish eaters were similar, in general, to the vegetarian group in terms of lifestyle characteristics and diet (see table). The regular oily fish consumers were least likely to smoke or use full-fat milk and were most likely to use dietary supplements. Although fat intake in the oily fish eaters was highest, the saturated fat intake and percentage of energy from fat was lowest and polyunsaturated fat intake highest. It is possible that health outcomes may influence choice of diet in the group, with 2% of the meat eaters and oily fish eaters reporting having had a heart attack in the past compared with only 1% in the other groups.

Our results have shown that fish eaters are different from other meat eaters and in epidemiological studies the groups should be distinguished. Oily fish eaters may prove a particularly interesting subgroup. Follow-up of these dietary patterns to assess impact on long-term health is now being carried out.

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Dietary intake during night shift and day shift in offshore shift workers. By M. GIBBS, S. HAMPTON, G. BENNETT, N. PAUL and L. MORGAN, *Nutrition and Metabolism Group, School of Biomedical and Life Sciences, University of Surrey, Guildford GU2 7XH*

Shift work in industrialized nations is increasing to meet the demands of a 24-h society; approximately 20% of the UK work force are engaged in shift work. There is a 40% increased risk of coronary heart disease (CHD) in shift workers (Boggild & Knutsson, 1999), which may in part be due to maladaptation of endogenous circadian rhythms to abrupt changes in shift times and relatively impaired glucose and lipid tolerance following meals eaten at night (Morgan *et al.* 1998). Some offshore shift workers can physiologically adapt to a night shift by about day 5 of a 2-week tour (Barnes *et al.* 1998). There is little published work on the effect of offshore shift work on dietary intake. Offshore shift workers provide a useful study group as they work in a fully catered environment, with a wide variety of foods available for self-selection. This study assessed dietary intake in offshore shift workers during two shift schedules to determine whether shift work influenced energy or macronutrient intake, or type of foods consumed. Postprandial lipid responses following night shift and day shift meals were measured to assess markers of CHD risk and any relationship with night shift diet intake or shift schedule.

Twenty-three healthy male subjects aged between 25 and 54 years were recruited from offshore oil and gas installations, working a schedule of 7 nights, 7 days (n 11) or 14 nights (n 12). Dietary intake was recorded by self-administered 24-h recall diaries, either in two 3-day periods (night & day shift) or 14 continuous nights, and analysed using Dietplan 5. Postprandial hormone and metabolite levels (triacylglycerol (TAG), glucose and insulin) were measured 6 h following daytime or night-time meals. Data were analysed by paired *t*-test or RM-ANOVA.

Mean nutrient intake	3 of 7 nights	SEM	3 of 7 days	SEM	Nights 1–5 of 14	SEM	Nights 6–13 of 14	SEM
Total energy (kJ)	8795	3163	9280	3063	8683	878	8030	233
CHO as % energy	43.9	7.26	45.7	6.98	41*	0.76	44*	0.84
Fat as % energy	35.3	6.67	33.8	6.74	40	0.36	39	0.60
Protein as % energy	20.9	5.03	20.4	4.73	19*	0.53	17*	0.47

There was a temporal redistribution of foods to an increase at night to match the sleep–wake cycle. No significant difference was found in total energy or macronutrient intake between day shift and night shift meals (7 night/7 day schedule). On the 14 night tour, there was a change in circadian rhythm timing indicating physiological adaptation to the night shift by day 6. There was also a significant decrease in the percentage of energy consumed as protein from night 6 on (*P 0.02) with a corresponding increase in carbohydrate consumption (*P 0.02). Plasma postprandial TAG and insulin responses showed a non-significant trend towards higher levels on the night shift compared with day shift (P 0.09) on the 7 night/7 day schedule. This difference may be accentuated when the confounding factor of free dietary choice is replaced with a standard test meal. No significant difference was found in other metabolic parameters measured.

We conclude that night shift work, on these schedules and in this fully catered environment, does not alter total energy intake, but that the choice of foods consumed may alter to achieve this. There may be an elevation in night-time postprandial plasma TAG and insulin levels and a change in macronutrient composition of energy intake when workers are not adjusted to their shift, that needs further investigation.

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Plasma n-3 fatty acid concentrations in omnivore, vegetarian and vegan men in the Oxford cohort of the EPIC study. By Z. LLOYD-WRIGHT[1], N. ALLEN[2], T.J.A. KEY[2] and T.A.B. SANDERS[1], [1]*Nutrition Food and Health Research Centre, King's College London, Franklin-Wilkins Building, London, SE1 9NN and* [2]*ICRF Cancer Epidemiology Unit, Gibson Building, Radcliffe Infirmary, Oxford OX2 6HE*

Linolenic acid (18:3n-3) is converted to long chain n-3 fatty acids, notably eicosapentaenoic acid (20:5n-3, EPA) and docosahexaenoic acid (22:6n-3, DHA) in animal tissues. Prospective cohort studies (Ascherio *et al.* 1996; Hu *et al.* 1999) have examined the relationship between the intake of n-3 fatty acids and CHD risk and shown that the intake of both linolenic acid and long chain n-3 fatty acids is associated with decreased risk of fatal CHD independent of known risk factors. We report plasma concentrations of n-3 fatty acids in omnivore (n 262), vegetarian (n 257) and vegan (n 249) men recruited into the EPIC study. Results are shown as mean values with 95% confidence intervals.
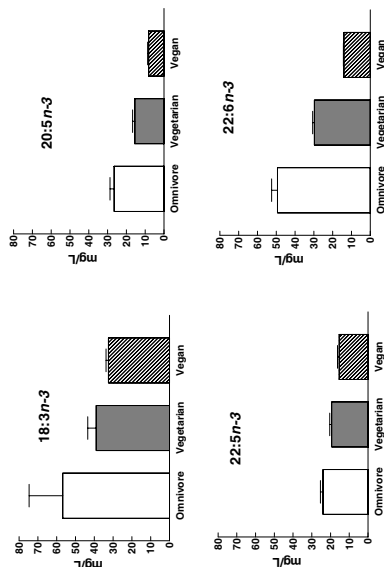
Plasma concentrations of all n-3 fatty acids were higher in the omnivores than in the vegetarians and vegans. The differences were most marked for EPA and DHA. The proportion of DHA in plasma lipids was 1.46 weight% in the omnivores, 1.02 weight% in the vegetarians and 0.62% in the vegans. The low DHA concentrations are in agreement with earlier studies (Sanders *et al.* 1978). The ratio of linolenic/linoleic acid in plasma of the omnivores, vegetarians and vegans was 20.5, 24.1 and 25.6, respectively. This would suggest that the low DHA concentrations were not a consequence of a high ratio of linoleic/linolenic acid in the diet. It seems likely that the variations in DHA concentrations are a consequence of preformed DHA in the diet. The intake of DHA in the omnivore subjects was estimated to be 50 mg/d (95% CI 40, 60). Whether these differences in plasma n-3 fatty acid concentrations are of pathophysiological significance remains to be determined.

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Dietary iron intakes in British adolescent children: a comparison between 1983 and 1997. By C.W. THANE and C.J. BATES, *MRC Human Nutrition Research, Elsie Widdowson Laboratory, Fulbourn Road, Cambridge CB1 9NL*

After 10 years of age, recommended daily iron intakes increase by around 30% in boys and 70% in girls (Department of Health, 1991), in order to counterbalance the additional requirements of rapid growth and, in girls, menstruation. Inadequate iron intake at this critical stage of life may compromise iron status, with the resulting deficiency manifesting symptoms such as anaemia, fatigue, poorer growth and immune function, and reduced learning capacity.

Adequacy of dietary iron intakes was compared in peripubescent children aged 10–11 and 14–15 years from two cross-sectional national surveys: the 1983 Schoolchildren's Dietary Survey (Department of Health, 1989) and the 1997 National Diet and Nutrition Survey of young people aged 4 to 18 years (Gregory *et al.* 2000). Dietary iron intakes were calculated here as daily intake (mg), iron density (mg/MJ energy intake), and are compared with the current UK recommendations (Department of Health, 1991). The analyses include only those subjects who provided complete 7 d weighed dietary records and exclude those who were unwell. The impact of possible under-reporting was also assessed (EI:BMR <1.39 and 1.30 in boys and girls, respectively; Torun *et al.* 1996), as was variation in dietary iron intake according to region, ethnicity, household income and receipt of income support.

Younger (10–11 year-old) boys in 1997 had higher dietary iron intakes than those in 1983, while in older (14–15 year-old) boys this was only true when expressed as iron density. In contrast with younger girls, older girls showed no difference in dietary iron intake between 1983 and 1997 (see table). Findings were not affected significantly (*P*≥0.05) after excluding possible under-reporters.

Index of dietary iron intake	10–11 years		14–15 years	
	1983	1997	1983	1997
Boys	*n* 861	*n* 107	*n* 471	*n* 89
Daily intake (mg)	9.6[a] (9.5, 9.7)	10.2 (9.7, 10.7)	11.7 (11.5, 12.0)	11.8 (11.0, 12.6)
Iron density (mg/MJ)	1.13[a] (1.12, 1.14)	1.27 (1.22, 1.33)	1.16[c] (1.14, 1.18)	1.30 (1.23, 1.37)
Percentage of RNI	94[b] (93, 96)	102 (97, 108)	104 (101, 107)	104 (97, 112)
Girls	*n* 776	*n* 97	*n* 438	*n* 84
Daily intake (mg)	8.3 (8.2, 8.5)	8.5 (8.1, 9.0)	8.9 (8.7, 9.1)	8.3 (7.6, 9.0)
Iron density (mg/MJ)	1.11[c] (1.10, 1.12)	1.20 (1.15, 1.26)	1.17 (1.14, 1.19)	1.21 (1.15, 1.27)
Percentage of RNI	70[a] (69, 72)	76 (71, 82)	60 (59, 62)	56 (52, 61)

Values are geometric means (95% CI). RNI, reference nutrient intake (10 y: 8.7 mg/d boys and girls; 11–15 y: 11.3 mg/d boys, 14.8 mg/d girls). Differences between surveys within respective age groups assessed by *t*-test (2-tailed). [a]*P*<0.05, [b]*P*<0.01, [c]*P*<0.001.

Increases in iron density between 1983 and 1997 were due to lower energy intakes in 1997. Many girls had dietary iron intakes below the lower reference nutrient intake (LRNI, 10 y: 4.7 mg/d; 11–15 y: 8.0 mg/d) in both years (16–46%), with more older girls in 1997 having such low intakes compared with those in 1983 (46 v. 32%; *P* 0.01, z-test). In contrast, only 1–3% of boys had intakes below the LRNI (10 y: 4.7 mg/d, 11–15 y: 6.1 mg/d). In both 1983 and 1997, older boys from households receiving income support had lower dietary iron intakes than those not receiving income support, indicating an association with socio-economic deprivation. However, a similar finding was not observed in younger or older girls from either survey.

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The effect of shift work on food intake and temporal salivary cortisol levels. By S.L. REEVES, T. LUCAS, N. MURRAY and D. DORLING, *Department of Sports, Health and Exercise Science, St Mary's College, Strawberry Hill, Twickenham TW1 4SX*

It has been suggested that shift work may be detrimental to health, since research has shown an increase in the incidence of weight gain, coronary heart disease (Tenkanen *et al.* 1998), risk of hypertension and gastrointestinal problems (Morikawa *et al.* 1999) in night shift workers. Possible reasons for these detrimental effects include unusual eating patterns, stress, and deviation from the natural circadian rhythm. Salivary cortisol has a distinct circadian rhythm. Deviations in this rhythm have been linked to stress, since high stress can trigger the release of corticotropin-releasing hormone from the hypothalamus which leads to the release of cortisol from the adrenal cortex (Rivier *et al.* 1986). This study compares the food intakes and salivary cortisol of day and night shift workers.

Eight night shift workers and eight day shift workers, of average age 54.8 years (SD 8.08) were recruited from the security guards at St Mary's College. All the subjects worked a 12-h shift starting and finishing at either 07.00 hours or 19.00 hours, as part of a 3 d rotating shift pattern. Food intake was recorded using 7 d diaries and the number of meals, snacks and drinks consumed were recorded in order to monitor discrete eating episodes. Subjects were also weighed, had their body composition estimated, their blood pressure measured and were asked to complete a lifestyle questionnaire. Cortisol was measured using saliva samples collected using Omni-Sal (SDS, UK) collectors, five times over a 24-h period and analysed using a TDX analyser (TDX, UK).

	Night shift		Day off	
	Mean	SD	Mean	SD
Nutrients				
Energy (kJ/24 h)	8160	1540	11590*	2895
Carbohydrate (g)	202.09	90	592.88**	139
Fat (g)	82.03	31	101.06	70
Protein (g)	86.32	29	119.29*	56
Alcohol (g)	10.41	4	44.37**	12
Eating Episodes				
Meals (24 h)	1.71	0.85	2.29*	0.73
Snacks (24 h)	2.86	1.39	1.29*	1.2
Drinks (24 h)	4.38	2.37	3.57	1.77
Salivary cortisol				
Day cortisol (nmol.l)	4.0	1.4	3.9	1.2
Night cortisol (nmol/l)	2.5	0.9	2.7	1.1

*$P<0.05$, **$P<0.001$.

No significant differences were observed between the night shift workers and the day shift workers for food intake, body weight and composition, blood pressure nor sick leave. Similar temporal salivary cortisol rhythms were observed in both the night and the day shift workers. Likewise, there were no differences in the food intakes of the day shift workers when at work or on days off. However, significant differences were observed for food intake in the night shift workers depending on whether they were at work or not. From this study, it may appear that shift work as part of a 3 d rotating shift pattern, does not upset the body's circadian rhythm nor significantly affect factors that relate to the health of night shift workers when compared to day shift workers. Further studies will assess the effect of shift work on physical activity and mental health.

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A preliminary study investigating the influence of food on the perception of visceral pain in healthy human volunteers. By S.A. ZMARZTY[1], J. FRANCIS[2] and N.W. READ[3], [1]*The Department of Community, Aging, Rehabilitation, Education and Research (CARER), University of Sheffield, Nurse Education Centre, Samuel Fox House, Northern General Hospital Trust, Sheffield S5 7AU,* [2]*School of Social Science and Law, Sheffield Hallam University, Sheffield and* [3]*The Centre for Human Nutrition, University of Sheffield, Northern General Hospital, Sheffield*

Our previous studies have shown that food, when ingested normally, significantly reduces pain perception in healthy human volunteers subjected to the cold-induced pain stimulus (Zmarzty *et al.* 1997). The maximum reduction in pain occurred 1.5 h after ingestion and a meal rich in fat exerted a significantly greater analgesic effect than an isoenergetic meal identical in appearance and taste, but high in carbohydrate (CHO). Much of the pain people experience, however, is of a visceral nature so the aim of this study was to investigate the effects of high CHO and fat meals on visceral pain perception in eight healthy human volunteers (five female and three male). All non smokers aged between 19 and 28 years (mean age 23.8 years) with a BMI of between 21 and 26.5 (mean BMI 23.8), and all habitually consumed a light breakfast.

All subjects underwent rectal distension tests on three occasions in a randomized counterbalanced order, before and after administration of isoenergetic high-fat low-CHO and high-CHO low-fat meals, and when no meal was given. The meals took the form of pancakes and the composition of the batter was covertly manipulated. The high-fat meal contained 54% energy from fat, 48% from carbohydrate and 5.2% from protein, and the high carbohydrate meal contained 88% from carbohydrate, 6.8% from fat and 5.2 from protein. The meals were individually portioned so that subjects ate one third of their daily energy requirements based upon their age, weight and description of their occupational and leisure activities.

The rectal pain stimulus was carried out three times on each test day, once before the meal, and 0.5 and 1.5 h after the meal, and at the equivalent times of the day when no food was given. Visual analogue scales (VAS) of emotional state were recorded before and after each set of rectal distensions. Recordings of rectal balloon pressures and volumes were computed for each painful rectal distension. All data were subjected to ANOVA for repeated measures.

It was found that following the high-fat low-CHO meal, significantly greater balloon volumes were tolerated ($F_{(2,14)}=4.22$, $P=0.037$*) accompanied by feelings of tiredness and relaxation, and following the high-CHO low-fat meal, significantly greater rectal pressures were tolerated ($F_{(2,14)}=6.64$, $P=0.009$*) accompanied by feelings of increased vigour.

These results suggest that food can reduce visceral as well as somatic sensitivity to pain in healthy human subjects, and might be explained by the concomitant reduction in emotional tension by high-fat foods and an increase in energy by high-CHO foods. Further research is planned to investigate the effects of food on rectal pain perception in irritable bowel sufferers (IBS) in order to evaluate the clinical efficacy of dietary manipulation in the management of patients in pain.

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Dietary fat consumption of women with reference to dieting status and the implications for coronary heart disease (CHD) development. By S.J. ROBERTS and S.M. MAXWELL, *Department of Education and Community Studies, Liverpool John Moores University, IM Marsh Campus, Barkhill Road, Aigburth, Liverpool L17 6BE*

High dietary fat intake, especially saturated fat, is associated with the development of CHD (British Heart Foundation, 1999). Reducing fat intake in order to lose weight is currently a popular measure amongst dieters (Roberts *et al.* 1999) and such action is also advocated in order to reduce the incidence of CHD (Department of Health, 1991). The incidence of CHD has in fact fallen in women by 30% in the 65–74 age group and by 17% in the 35–44 age group over the last 10 years (British Heart Foundation, 1999).

Female dieters over the age of 18 years of age (range 18–55), following self-selected reducing diets, were invited to take part in the study (n 50), a subgroup of twenty non-dieters were also recruited for a comparison. Dietary intake was assessed by using a 3 d estimated food diary and analysed using Microdiet (University of Salford).

Nutrient	Dieters (n 50)			Non-dieters (n 20)			DNSBA*		DRV**
							Dieter	Non-dieter	
	Mean	SD	Range	Mean	SD	Range	Mean	Mean	
Energy (kJ)	5816	1351	2288–8544	6740	1104	3758–8665	5858	7196	
% Energy from									
Total fat	29.4	8.8	13.4–1.5	35.0	7.4	20.1–47.55	38.2	40.6	<35
Saturated fat	10.5	4.2	3.93–21.7	13.6	3.6	8.5–20.19	17.7	15.6	<11
PS Ratio[†]	0.51	0.252		0.46	0.174		0.40	0.38	

* DNSBA, Dietary and Nutritional Survey of British Adults (Gregory, 1990).
** DRV, Dietary Reference Value (Department of Health, 1991).
[†] PS Ratio; ratio of polyunsaturated to saturated fatty acids.

This study shows that over the last 10 years there has been a decrease in fat consumption among the female population as a whole, which may reflect to some extent the falling CHD death rates amongst women over this period. Comparing the mean results with DRVs would suggest that dieting females are consuming a diet which is less conducive to CHD development than non-dieters. Although not statistically significant, a higher percentage of non-dieters than dieters had a saturated fat intake above the DRV, 66.7% and 44.2%, respectively. The range of results suggests that certain individuals may remain at risk from developing CHD because of high fat consumption; however, excessively low fat consumption may also predispose to other health problems. Dieters may have a more desirable fat intake because they are better informed about healthy eating; many weight loss plans now promote the development of a 'healthy lifestyle'.

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Dietary intake and quality of life in patients with cancer of the head and neck twelve months after completion of radiotherapy treatment. By A.E. PICKINGS[1], S. FELLOWS[2], C.G. KELLY[2] and C.J. SEAL[1], [1]*Human Nutrition Research Centre, Department of Biological and Nutritional Sciences, University of Newcastle, Newcastle upon Tyne NE1 7RU and* [2]*The Northern Centre for Cancer Treatment, Newcastle General Hospital, Westgate Road, Newcastle upon Tyne NE4 6BE*

We have previously reported the negative effects of radiotherapy treatment on dietary intake and quality of life in patients with cancer of the head and neck (Broadhead *et al.* 2001*a,b*). These results showed a marked deterioration in macronutrient consumption throughout a 6-week course of treatment, which was accompanied by a progressive decline in patient quality of life. There is little information available on the recovery of diet or quality of life in these patients following treatment. Our objective, therefore, was to investigate these factors retrospectively in patients 12 months after completion of their course of radiotherapy treatment.

Nine patients (eight male) of fourteen who had been interviewed between October and December 2000 were able to take part in the follow-up study. The average age of patients was 61 years (range 39–73). Each patient completed the same dietary and quality of life (QoL) questionnaires as before which included a 4 d retrospective food frequency questionnaire (FFQ) questionnaire (Aaronson *et al.* 1993) to estimate portion sizes (Nelson *et al.* 1997) and the EORTC QoL questionnaire (Aaronson *et al.* 1993). Patients also completed a retrospective questionnaire with a face-to-face interview to assess changes in diet and lifestyle during the 12 month period following completion of treatment. Nutrient intakes were calculated from the FFQ and portion size estimates using Microdiet (University of Salford). Data were analysed by ANOVA with *post hoc* analysis of the difference between stages of treatment and follow-up period using Dunnett's 2-sided test.

	Treatment stage				Significance of effects	
Dietary intake	Before	End	12 Month	SEM[†]	Before *v.* 12 Mo	End *v.* 12 Mo
Total energy (kJ/d)	9116	5402	10682	852.2	0.690	0.014
Carbohydrate (g/d)	267.2	160.1	331.0	31.14	0.661	0.041
Sugars (g/d)	92.5	103.6	210.3	22.91	0.097	0.092
Starch (g/d)	144.5	36.4	118.6	14.61	0.667	0.015
Total fat (g/d)	81.6	43.9	86.3	7.84	0.964	0.040
SFA (g/d)	29.3	20.8	36.1	3.22	0.664	0.100
PUFA (g/d)	10.8	3.6	10.5	1.40	0.995	0.069
MUFA	24.2	12.2	27.7	2.59	0.820	0.019
Protein (g/d)	85.8	51.5	74.7	6.65	0.773	0.226
Fibre (g/d)	18.8	4.5	14.8	1.77	0.490	0.008

[†]SEM, pooled standard error.

Energy intakes, which fell significantly during radiotherapy treatment, had recovered to pre-treatment levels by the 12 month follow-up. The pattern of nutrients consumed had also returned to that seen pre-treatment. Intake of sugars, although not statistically significant, appeared to be higher at the 12 month follow-up. A significant reduction in the incidence of constipation (reduction in QoL score from 2.1 to 1.3, *P*<0.003) may be associated with a significant increase in fibre consumption (*P*=0.008). Five of the six patients who had a loss of appetite during treatment reported a recovery in appetite after completion of radiotherapy, with estimated recovery times ranging from 3 weeks to 7 months. Similar recovery times for taste to return to normal were also reported. Although some QoL measures had deteriorated during the 12 month period, overall QoL, especially those measures of eating and swallowing, had significantly improved.

The results show an improvement in dietary intake and recovery in QoL during the 12 months following treatment. For some patients, however, the time to recovery was prolonged and this represents a period of continuing concern for the long-term management of patient care.

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Folate protects human low-density lipoprotein against oxidative modification. By E. NAKANO[1], J.A. HIGGINS[2] and H.J. POWERS[1], [1]Centre for Human Nutrition, Division of Clinical Sciences, Northern General Hospital, University of Sheffield, Sheffield S5 7AU and [2]Department of Molecular Biology and Biotechnology, University of Sheffield, Firth Court, Western Bank, Sheffield S10 2TN

Elevated plasma total homocysteine is considered to be a graded risk factor for cardiovascular disease (Boushey et al. 1995). Folate lowers the concentration of homocysteine by a vitamin B[12]-dependent methylation to methionine, and may therefore be protective for cardiovascular disease. Folate, however, may have other protective effects independent of homocysteine lowering. We have measured the effects of folate on copper-catalysed oxidative damage to the unsaturated lipids in human low-density lipoprotein (LDL).

LDL was prepared using a rapid and efficient method (Graham et al. 1996) that is capable of producing pure LDL within 5 h of collecting the blood. Experiments were carried out in the presence of citrate, which gives reproducible results and in vivo-like conditions. LDL lipid oxidation was monitored by an increase in absorbance at 234 nm, which measures the amount of conjugated diene produced. There is a lag time during which endogenous antioxidants are oxidized, followed by rapid oxidation of lipid. Addition of 0–6 μM 5-methyl tetrahydrofolate (MTHF) produced a dose-dependent increase in the lag time.
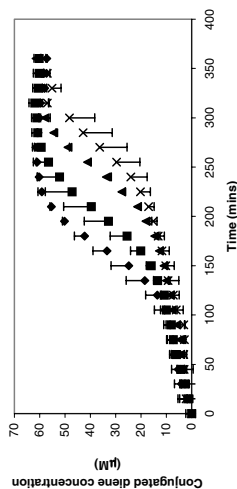
Concentration of conjugated dienes resulting from LDL oxidation as a function of time, in the presence of increasing amounts of 5-methyl tetrahydrofolate. ♦: control; ■: 1 μM MTHF; ▲: 4 μM MTHF; ✕: 6 μM MTHF. Conjugated diene concentration is calculated from the absorbance at 234 nm. The means (± SD) of three experiments are shown.

These results suggest that folate may have a direct anti-oxidant role in vivo, which is independent of and in addition to any indirect effects resulting from lowering of homocysteine levels. They therefore add additional weight to suggestions that folate supplementation in the general population may have vasculoprotective effects (Wilmink et al. 2000).

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Limited conversion of α-linolenic acid to docosahexaenoic acid in men. By G.C. BURGE[1], Y.E. FINNEGAN[2], A.M. MINIHANE[2], P. WRIGHT[1], C.M. WILLIAMS[2] and S.A. WOOTTON[1], [1]Institute of Human Nutrition, Southampton General Hospital, Tremona Road, Southampton, SO16 6YD and [2]Hugh Sinclair Unit of Human Nutrition, School of Food Biosciences, Department of Food Science, University of Reading, Reading RG6 6AP

The relative concentration of n-3 polyunsaturated fatty acids (PUFA), principally eicosapentaenoic (EPA) and docosahexaenoic (DHA) acids, in membrane phospholipids is important regulator of cell function. Since the precursor of EPA and DHA, α-linolenic acid (ALNA), is the predominant n-3 fatty acid in the Western diet, metabolic capacity for inter-conversion of ALNA may be important for maintaining membrane n-3 PUFA concentrations. We have investigated the extent of ALNA inter-conversion in men maintained on a diet with standardized n-3 fatty acid intake.

Healthy men (26–69 years) (n 14) maintained their habitual diet, but substituted butter/margarine with margarine representative of the typical UK fatty acid intake (Finnegan et al. 2001). After 4 weeks, subjects consumed a meal containing [U-^{13}C]ALNA (700 mg; Burdge et al. 2001). ALNA inter-conversion was assessed from the sum of labelled fatty acid concentrations at 6, 10, 24 and 48 h in plasma triacylglycerol (TAG), non-esterified fatty acids (NEFA) and phosphatidylcholine (PC) measured by gas chromatography-combustion-isotope ratio mass spectrometry (Burdge et al. 2001).

The highest [^{13}C]ALNA concentrations were at 6 h in plasma TAG and NEFA and 10 h in PC. Labelled EPA, docosapentaenoic acid (DPA) and DHA concentrations were greatest at 10 h for EPA, DPA and DHA in TAG and at 48 h in PC. Cumulative [^{13}C]ALNA concentration in plasma TAG was significantly greater than in NEFA (23.7-fold) and PC (4.7-fold). Labelled -EPA, -DPA and -DHA excursions were greater in plasma PC compared with TAG and NEFA. The relative labelled fatty acid excursions in total plasma were [^{13}C]ALNA 95.6%, EPA 3.0%, DPA 1.3% and DHA 0.1%.

| | [^{13}C]ALNA | | [^{13}C]EPA | | [^{13}C]DPA | | [^{13}C]DHA | |
| | | | | | Cumulative plasma [^{13}C]-fatty acid concentration (μmol/l) | | | |
Lipid class	Median	Range	Median	Range	Median	Range	Median	Range
TAG	45.1	2.4 – 104.4	0.5	0.2 – 1.9	0.13	0.04 – 2.20	0.001	0.001 – 0.003
NEFA	1.9[*]	1.1 – 2.6	0.003[*]	0 – 0.03	0.007[*]	0.001 – 0.02	0.002	0.001 – 0.007
PC	9.7[*,***]	1.9 – 15.8	1.3[**,***]	0.003 – 2.0	0.16[***]	0.004 – 0.43	0.02[**,***]	0 – 0.06

Values significantly different between *TAG and NEFA (P<0.001), **TAG and PC (P<0.05), ***PC and NEFA (P<0.001).

Apparent EPA and DPA synthesis was low and at similar levels to our previous report (Burdge et al. 2001). We have reported previously that men were apparently unable to synthesize DHA from labelled ALNA (Burdge et al. 2001). Although this study showed some, albeit limited, DHA synthesis, the extent of conversion of ALNA to DHA appeared to be severely constrained. Together these data suggest that the extent of ALNA conversion to n-3 PUFA was limited, although it is not known whether this is sufficient to satisfy the demands of these individuals for EPA, DPA and DHA. Comparison with our previous study (Burdge et al. 2001) suggests that metabolic capacity for ALNA inter-conversion may differ markedly between subject groups, which may reflect differences in the ability of individuals to meet their demands for n-3 PUFA.

Burdge GC, Jones AE, Wright P, Ware L & Wootton SA (2001) Proceedings of the Nutrition Society **60**, 22A.
Finnegan YE, Leigh-Firbank EC, Minihane AM & Williams CM (2001) Proceedings of the Nutrition Society **60**, 22A.

α-Linolenic acid metabolism in men: effect of altering dietary n-3 polyunsaturated fatty acid intake.

By G.C. BURDGE[1], Y.E. FINNEGAN[2], A.M. MINIHANE[2], P. WRIGHT[1], C.M. WILLIAMS[2] and S.A. WOOTTON[1], [1]Institute of Human Nutrition, Southampton General Hospital, Tremona Road, Southampton, SO16 6YD and [2]Hugh Sinclair Unit of Human Nutrition, Department of Food Science, University of Reading, Reading RG6 6AP

Metabolic capacity to convert dietary α-linolenic acid (ALNA) to n-3 polyunsaturated fatty acids (PUFA) may be an important mechanism for maintaining eicosapentaenoic (EPA) and docosahexaenoic (DHA) acid concentrations in membranes and, in turn, regulating cell function. The effect of fatty acid intake upon ALNA inter-conversion in man is poorly understood. We have carried out a longitudinal study to determine the effect of increasing ALNA (substrate) or EPA/DHA (product) in the background diet on the extent of ALNA inter-conversion in men.

Healthy men (26–69 years) (n 14) were initially maintained for 4 weeks on a control diet in which their usual margarine/butter was replaced with margarine representative of the typical UK fatty acid intake (Finnegan et al. 2001). Subjects then consumed a meal containing [U-^{13}C]ALNA (700 mg) (Burdge et al. 2001). Metabolic capacity for ALNA inter-conversion was assessed from the cumulative concentrations of labelled ALNA, EPA, DPA and DHA in plasma phosphatidylcholine (PC) over 48 h using gas chromatography–isotope ratio mass spectrometry (Burdge et al. 2001) (Trial 1). Subjects were then randomized to either maintaining the control diet (n 5), a high ALNA (10 g/d) (n 4) or high EPA/DHA (1.5 g/d) (n 5) diet for 8 weeks. The metabolic study was then repeated (Trial 2). The differences between trials in cumulative concentrations of labelled fatty acids over 48 h within each dietary group are presented in the table.

There was no significant change in plasma PC n-3 fatty acid composition or cumulative concentrations of labelled fatty acids between trials on the control diet (not shown). The high ALNA diet increased the median plasma PC EPA concentration by 85.4 (45.9 to 116.7) mmol/l (P<0.05). The EPA/DHA diet increased plasma PC EPA concentration by 72.4 (55.2 to 130.9) mmol/l (P<0.05) and DHA by 141.5 (80.7 to 200.1) mmol/l (P<0.05). Increased ALNA intake did not alter the cumulative concentrations over 48 h of labelled ALNA, EPA, DPA or DHA. In contrast, EPA and DPA synthesis were decreased significantly by increasing dietary EPA/DHA content.

| | Change in cumulative [^{13}C]-labelled fatty acid concentration over 48h (trial 2 – trial 1) (μmol/l) | | | | | | | |
| | [^{13}C]ALNA | | [^{13}C]EPA | | [^{13}C]DPA | | [^{13}C]DHA | |
Diet	Median	Range	Median	Range	Median	Range	Median	Range
High ALNA	−1.6	−3.2 to 1.9	0.01	−0.7 to 0.8	−0.05	−0.12 to 0.08	0.01	0.002 to 0.03
High EPA/DHA	0.5	−5.6 to 8.0	−0.7*	−1.2 to 0.5	−0.13*	−0.3 to −0.04	0.02	−0.02 to 0.05

*Values significantly different (P<0.05) between trials 1 and 2.

Maintenance on the control diet suggested that plasma PC n-3 fatty acid composition and capacity for ALNA inter-conversion was relatively consistent over 8 weeks. Increasing ALNA intake may be a suitable means for increasing EPA, but not DHA, status. Increasing EPA/DHA intake raised plasma EPA and DHA concentrations, but exerted a significant product-inhibition of EPA and DPA synthesis. DHA synthesis was unaffected by diet and so may be regulated independently by the physiology, dietary history or health of an individual.

Burdge GC, Jones AE, Wright P, Ware L & Wootton SA (2001) Proceedings of the Nutrition Society 60, 22A.
Finnegan YE, Leigh-Firbank EC, Minihane AM & Williams CM (2001) Proceedings of the Nutrition Society 60, 22A.

Hypotriacylglycerolaemic effects of fish oils in British Sikhs and Caucasians.

By J.A. LOVEGROVE[1], S.V.M. LESAUVAGE[1], S.S. LOVEGROVE[1], N. SAINI[1], B.A. GRIFFIN[2], A.M. MINIHANE[1] and C.M. WILLIAMS[1], [1]School of Food Biosciences, University of Reading, Whiteknights, Reading RG6 6A and [2]School of Biological Sciences, University of Surrey, Guildford GU2 5XH

British Asians have lipid abnormalities indicative of an atherogenic lipoprotein phenotype (ALP). This includes high plasma triacylglycerol, low plasma HDL cholesterol and high plasma small dense LDL (LDL 3, the highly atherogenic lipoprotein) levels and insulin resistance (Laws et al. 1994). It has been reported by our group that the dietary intake of long-chain n-3 PUFA (eicosapentaenoic acid and docosahexaenaeoic acid) were significantly lower in Sikhs compared with Caucasians living in the UK (Lesauvage et al. 2001). Since raised TAG are thought to be the primary abnormality of an ALP we have speculated that the plasma lipid profile of Sikhs may benefit from an increased dietary long-chain n-3 PUFA intake. This study investigated the effect of a daily 2.0 g eicosapentaenoic acid and docosahexaenoic acid (4.0 g fish oil) supplement (or placebo, 4.0 g olive oil) for 12 weeks on plasma lipids in two ethnic groups. The Caucasian (n 44) and Sikh subjects (n 40) were matched for age (mean (SD): 47 (11) v. 49 (12) years respectively) and BMI (25.8 (3.3) v. 26.0 (3.1) kg/m^2 respectively). The Sikh group had significantly (P<0.05) higher plasma triacylglycerol (TAG) levels at baseline compared with the Caucasians (1.67 (0.99) v. 1.17 (0.52) mmol/l respectively) and a significantly (P<0.01) higher number of the Sikh group had LDL 3 >40% total LDL cholesterol compared with the Caucasians at baseline (29% v. 11%, respectively). The fish oil and placebo groups were randomly assigned and stratified for TAG, BMI, sex and age. Subjects took the supplement daily for 12 weeks. Fasting blood samples were taken at 0, 6, 12 and 16 weeks and plasma TAG, total, HDL and LDL cholesterol, non-esterified fatty acids and glucose were determined.
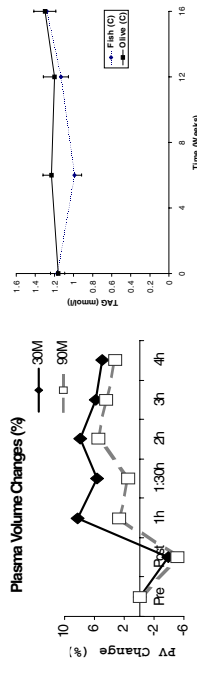
A significantly lower plasma TAG concentration was observed in the Sikhs on fish oil compared with placebo at 12 weeks (1.13 (0.48) v. 1.73 (1.15) mmol/l respectively, P=0.04) as shown in the figure. The hypo-triacylglycerolaemic effect of fish oil was significantly greater in the Sikhs compared with the Caucasians (19% v. 3% reduction, respectively, P=0.03). These results illustrate that Sikhs are very responsive to the TAG lowering effects of n-3 PUFA supplementation and may benefit from additional dietary n-3 PUFA intake.

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Polyunsaturated fatty acid content of plasma can be modulated by dietary supplementation with flaxseed-enriched bread: comparison with encapsulated supplementation. By N.C. PEGGE[1], R.C. FIELD[1], A.M. TWOMEY[2], I.F.W. McDOWELL[3], M.I. LEWIS[1] and M.W. RAMSEY[2], *Departments of [1]Pharmacology, Therapeutics and Toxicology, and [3]Medical Biochemistry, University of Wales College of Medicine, Cardiff CF14 4XN and [2]Cardiac Centre, Morriston Hospital, Swansea SA6 6NL*

Flaxseed is a rich source of the long chain n-3 polyunsaturated fatty acid (PUFA) α-linolenic acid (ALA, C18:3n-3). Sequential chain elongation and desaturation of ALA in man is thought to be relatively inefficient. We compared the effect of bread milled with flaxseed and pure ALA capsules over 6 months on fasting plasma PUFA content and lipid profile.

After ethical approval, 200 asymptomatic volunteers (eighty-five male, aged 20–65 years) were recruited from among staff and from friends and non-blood relatives of patients at the two cardiac centres in Wales. Exclusion criteria were pregnancy, diabetes mellitus, hypertension (blood pressure >160/90 mmHg), heart failure, any heart valvular disease; and stroke, myocardial infarction or angina within 3 months. Informed written consent was obtained. Subjects were randomized to 6 months dietary intervention in one of four parallel groups: either opaque capsules containing 1 g pure ALA, matching capsules containing non-absorbed placebo, bread fortified with flaxseed (Holgran, Burton-on-Trent), or matching placebo bread. Subjects were asked to consume either two capsules or four slices of bread per day, formulated to yield 2 g of ALA. At randomization and at conclusion, venous blood was drawn, fasting, without stasis from an antecubital vein into tubes containing lithium heparin, was separated immediately by refrigerated centrifugation, and then frozen at −70° until analysis of PUFA content; fasting blood was also taken for measurement of lipid profiles. The semi-quantitative DietQ questionnaire was administered before and after intervention.

PUFA (mg/dl)	Active capsule: baseline mean	SD	End mean	SD	Active bread: baseline mean	SD	End mean	SD
ALA	2.4[S]	1.1	3.8[S]	1.7	2.3[S]	0.9	2.7[S]	1.1
EPA	3.0[S]	1.8	4.1[S]	2.8	3.6	2.4	3.6	2.5
DHA	7.4	2.8	7.4	3.1	6.9	2.8	6.9	2.7

Plasma ALA levels increased by 62% with active capsules and by 18% with flaxseed bread ($P<0.001$ and $P=0.01$, respectively, [S] indicates significance in table). The increment in the active capsule group was significantly greater than with bread ($P=0.001$, ANCOVA). Plasma EPA increased by 35% with capsule supplementation, significantly more than with bread ($P=0.002$), and there were no significant changes in DHA content. Placebo supplementation had no significant effect, and there were no significant differences in PUFA content between groups at baseline. No intervention had any effect on total, or high- or low-density lipoprotein cholesterol, or triacylglycerols. Analysis of the questionnaire data revealed no significant differences in calorific, carbohydrate, total fat or protein intake between or within groups.

Thus dietary supplementation with flaxseed-enriched bread sufficient to yield 2 g per day of ALA results in significant changes in plasma PUFA profile. These changes are less profound than with encapsulated supplementation, and this may reflect either bioavailability or compliance. Metabolism of ALA to longer chain PUFA seems limited to an increase in EPA without change in DHA.


Effect of the menstrual cycle on the basal metabolic rate in naturally cycling women. By H.J. LIGHTOWLER, C.J.K. HENRY and D. WILSON, *Nutrition and Food Science Group, School of Biological and Molecular Sciences, Oxford Brookes University, Gipsy Lane Campus, Headington, Oxford OX3 0BP*

The validity and use of the basal metabolic rate (BMR) in calculating an individual's total energy requirements are based on the assumption that intra-individual variation in BMR is small. Previous research has demonstrated a biological constancy of BMR in males (Henry *et al.* 1989); however, little information exists on intra-individual variation of BMR in females.

Early studies have suggested that BMR in females displays evidence of periodicity in conjunction with the menstrual cycle, whereas other studies have shown no demonstrable cyclical difference (Solomon *et al.* 1982). The aim of this study was to investigate the effect of the menstrual cycle on BMR and the intra-individual variation in naturally cycling females.

Fourteen naturally cycling females, mean age 25 (SD 7.4) years, mean BMI 23.8 (SD 5.2) kg/m², were recruited to the study. Sequential measurements of BMR were made, over one menstrual cycle, using a Deltatrac Metabolic Monitor and were carried out under normal conditions. Each menstrual cycle was normalized and expressed as a total of 100%; ovulation corresponded to 50%. Levels of inter- and intra-individual variation of BMR were assessed by determining the coefficient of variation (CV).

Mean BMR was 5.69 (SD 0.74) MJ/d, with a CV of 13%. The CV of individual subjects' data ranged from 2 to 13%.

Variation in BMR for all subjects
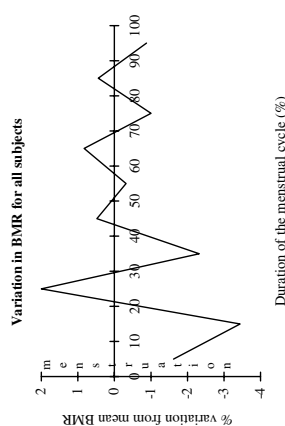
It has been suggested that BMR during the menstrual cycle is biphasic. However, the results from this study showed no significant difference in BMR during the early follicular phase (taken as 15% of the menstrual cycle) and late luteal phase (taken as 85%), suggesting that BMR does not vary periodically in conjunction with the menstrual cycle.

There was a high level of intra-individual variation in BMR in the subjects. The CV in three females was at a level comparable to men (2–4%) (Henry *et al.* 1989). However, intra-individual variation in the BMR of the other eleven females was higher, highlighting that BMR may not be considered a biological constant in females.

Work is in progress to investigate the relationship between the menstrual cycle and food selection and the associated impact on energy balance and body weight regulation in free-living females.

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Lipid digestion and absorption during rehabilitation from severe childhood malnutrition. By J.L. MURPHY[1], V.A. BADALOO[2], B. CHAMBERS[2], A. HOUNSLOW[1], T.E. FORRESTER[2], S.A. WOOTTON[1] and A.A. JACKSON[1], [1]Institute of Human Nutrition, University of Southampton, Southampton SO16 6YD and [2]The Tropical Metabolism Research Unit, University of the West Indies, Jamaica

During the treatment of malnourished infants, extra lipid is routinely added to the standard formula to increase the energy density of the intake based on the general impression that there is a reduction in the availability of dietary lipid and to promote rapid catch-up growth. Much of our understanding is based upon a few early studies that have examined the impact of diets generally low in lipid (about 30 g/day) on the digestion and absorption of dietary lipid during treatment. Little is known about the extent to which large amounts of extra lipid as part of dietary management (WHO, 1999) might influence the gastrointestinal handling of dietary lipid in severe malnutrition and during rehabilitation.

In the present study we report our findings on the excretion of lipid in stool in thirty-two severely malnourished children (aged between 5 and 23 months) admitted to the Tropical Metabolism Research Unit for treatment. Children were recruited to the study with a weight for age of less than 80% normal weight for age and/or presence of pitting oedema; marasmus, marasmic-kwashiorkor and kwashiorkor. Stools were collected over a 3 d period on three occasions: on admission (Phase 1), during rapid catch-up growth (Phase 2) and when weight for height had reached 90% of the reference (Phase 3). On admission the children were started immediately on a milk-based diet based on a commercial infant feed with the addition of corn oil. Once appetite was restored on this regimen, greater amounts of energy and protein were offered to promote weight gain. The amount of lipid consumed was calculated from the amount of feed consumed determined by weighing the cups before and after feeding. The lipid content of stool was determined by a modification of Folch et al. (1957). The results are shown in the table as medians (minimum to maximum).

	Phase 1		Phase 2		Phase 3	
Lipid intake (g/d)	31.8	(16.7–72.3)	49.4	(27.2–104.2)	57.6	(26.9–98.2)
Stool lipid (g/d)	2.3	(0.1–11.2)	2.3	(0.2–7.1)	2.1	(0.1–7.0)
Stool lipid (% lipid intake)	8.8	(0.3–32.7)	5.6	(0.2–16.5)*	4.8	(0.1–15.3)**

Significantly different from Phase 1 * $P<0.05$; ** $P<0.01$ (Friedman repeated measures).

Lipid intake and stool lipid excretion varied markedly within the group, both at admission and during recovery. When lipid in stool was expressed as a percentage of lipid intake, stool losses at admission (Phase 1) ranged from <1% up to 33% (median 9%). In normal healthy children stool lipid losses are usually less than 4% of the lipid consumed (Murphy et al. 1991). Twenty-one of the children at admission had lipid losses greater than 4% of intake. During rehabilitation, there was a reduction in eleven of these children with elevated losses to less than 4% by Phase 3. These results suggest that, despite adding large amounts of extra lipid to the diet, the majority of children with severe malnutrition have the capability to digest and absorb dietary lipid with progressive improvement during rehabilitation. However there are children who still show evidence of impaired lipid-handling and gastrointestinal dysfunction that may lead to an underestimate of the energy provision available for metabolism.

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Differential sensitivity of mismatch repair deficient colorectal cancer cell lines to butyrate. By E.A. WILLIAMS, W. BAL and J.C. MATHERS, Human Nutrition Research Centre, University of Newcastle, Wellcome Laboratories, Royal Victoria Infirmary, Newcastle upon Tyne NE1 4LP

Hereditary non-polyposis colorectal cancer (HNPCC) is an autosomal dominant condition associated with a high incidence of early onset colorectal cancer (CRC). Individuals with HNPCC have a mutation in one of five DNA mismatch repair (MMR) genes. Proteins encoded by these genes recognize and repair short mismatched sequences of DNA. MMR gene mutations are associated with instability in simple repeat nucleotide sequences (microsatellites), the mutator phenotype characteristic of HNPCC which is also observed in 17% of sporadic CRC. A genetic selection for microsatellite stable cells and an elimination of unstable cells via apoptosis has been reported in MMR-deficient CRC cell lines exposed to nonsteroidal anti-inflammatory drugs (Rüschoff et al. 1998). The short-chain fatty acid, butyrate, produced by fermentation of carbohydrates in the colon, has been postulated to be protective against CRC via its ability to inhibit proliferation and enhance apoptosis in neoplastic colonocytes.

This experiment was designed to investigate the effect of 12-week butyrate exposure on cell proliferation in MMR-deficient and MMR-proficient CRC cell lines. Three MMR-deficient (HCT15, HCT116, LoVo) and two MMR-proficient (SW480, HT29) CRC cell lines were exposed to 1 mM butyrate-enriched media for 12 weeks and then restored to normal media for a further 6 weeks. Cells were harvested and counted at weekly intervals and each flask was reseeded at the original seeding density. Media were changed in each flask twice weekly. The figure illustrates the mean (SEM) number of viable cells, exposed to 1 mM butyrate compared with control in MMR-deficient and proficient cell lines.
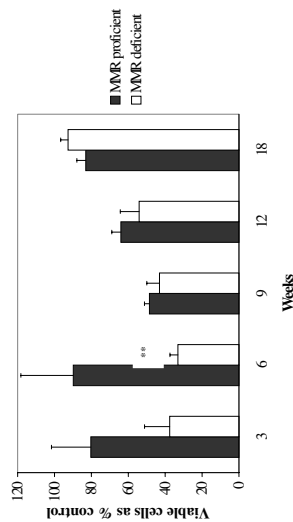
Mean values were significantly different from MMR proficient: ** $P<0.01$.

Cell proliferation was suppressed in all cell lines upon long-term exposure to butyrate-enriched media. However, a more pronounced suppression was observed in MMR-deficient cells than the MMR-proficient cells. Return of the cells previously exposed to 1 mM butyrate to normal media restored cell viability.

The MMR-deficient cell lines were significantly more sensitive to the anti-proliferative effects of butyrate exposure but the mechanisms responsible for this differential sensitivity of MMR-deficient cell lines are unknown. Further research is under way to determine whether this effect is mediated via a selection for microsatellite stable cells.

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Correlation between placental nutrient transport and birth weight in pregnancies complicated by maternal diabetes. By M.R. FOSTER, T.I. BIRDSEY, C. BRUCE, S.J. BARTON and R.B. FRASER, *Department of Obstetrics and Gynaecology, University of Sheffield, Jessop Wing, Sheffield S10 2SF*

Fetal overgrowth is commonly observed in pregnancies complicated by maternal diabetes (Fraser, 1995). The exact causes of excessive fetal growth in these pregnancies are uncertain. However, where fetal overgrowth occurs, the net maternal–fetal transfer of nutrients by the placenta must, by definition, be increased. We have investigated the relationship between birth weight and transport of amino acids and glucose in placental cells isolated from diabetic women.

The syncytiotrophoblast (the transporting layer of the human placenta) is formed by fusion and differentiation of cytotrophoblast cells (cyts). Cyts, when isolated and maintained *in vitro*, undergo a process of differentiation similar to that occurring *in vivo*, and thus are used to model the *in vivo* syncytiotrophoblast (Greenwood *et al.* 1996). Cyts were isolated from placentas of women with preexisting diabetes and pregnancy-induced impaired glucose tolerance. Once isolated, cyts were maintained in culture for 66–72 h. Amino acid transport was evaluated at 37° by assessing intracellular accumulation of ^{14}C-aminoisobutyric acid (^{14}C-AIB) over a period of 30 min. Cells were depleted of amino acids for 2 h and amino acid uptake initiated by addition of buffer containing trace ^{14}C-AIB and 50 μM unlabelled AIB. ^{14}C-AIB uptake was assessed in the absence of sodium to allow evaluation of sodium-independent transport processes. In order to evaluate glucose transport, intracellular accumulation of ^{14}C-3-O-methylglucose (^{14}C 3OMG) was measured at room temperature, over a period of 30 s. The cells were depleted of glucose for 1 h and uptake initiated by addition of buffer containing trace ^{14}C-3OMG and 1 mM unlabelled glucose. Uptake was terminated by aspiration of the radioactive solution and washing with ice-cold buffer. For evaluation of ^{14}C-3OMG uptake, the wash solution contained 0.5 mM phloretin. Cells were solubilized with NaOH allowing determination of intracellular ^{14}C-AIB, ^{14}C-3OMG and protein content. Uptake was calculated as (nmol/mg protein). Data were correlated to infant birth weight (see Figures a and b).
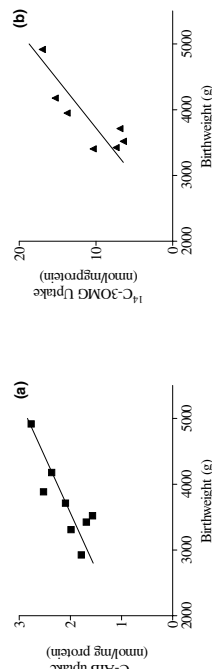
Linear regression analysis demonstrated a significant correlation between infant birth weight and both sodium-independent ^{14}C-AIB uptake ($P<0.01$, n 8, Figure 1a) and ^{14}C-3OMG uptake ($P<0.05$, n 7, Figure 1b) in cyts isolated from placentas of diabetic women.

The data suggest that alterations in placental nutrient transport mechanisms may contribute to disordered fetal growth associated with pregnancy complicated by maternal diabetes.

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Higher plasma di-homo-gamma-linolenic acid and arachidonic acid content are associated with endothelial dysfunction in man. By N.C. PEGGE[1], R.C. FIELD[1], A.M. TWOMEY[2], I.F.W. McDOWELL[3], M.J. LEWIS[1] and M.W. RAMSEY[2], *Departments of* [1]*Pharmacology, Therapeutics and Toxicology, and* [2]*Medical Biochemistry, University of Wales College of Medicine, Cardiff CF14 4XN and* [2]*Cardiac Centre, Morriston Hospital, Swansea SA6 6NL*

Secular trends in western nutrition have lead to changes in the ratio of *n-3* to *n-6* polyunsaturated fatty acids (PUFA) present in human diet. Reduction in use of saturated fatty acids in cooking has been accompanied by an increase in *n-6* rich vegetable oil consumption. Epidemiological evidence suggests that populations whose diets are rich in long-chain *n-3* PUFA have a lower prevalence of atherosclerosis. One dietary intervention study has suggested that increasing intake of a shorter chain *n-3* PUFA, α-linolenic acid (C18:3*n*-3, ALA), reduces recurrent cardiac events in a western population with previous myocardial infarction (de Lorgeril *et al.* 1999). Dietary supplementation with the longer chain *n-3* PUFA eicosapentaenoic (C20:5*n*-3, EPA) and docosahexaenoic (C22:6*n*-3, DHA) acids improves endothelial function in hypercholesterolaemic subjects (Goodfellow *et al.* 2000). Dietary supplements containing *n-6* PUFA such as evening primrose oil are commercially promoted as beneficial for health and for the relief of pre-menstrual symptoms, but their impact on endothelial function as a marker of vascular health is unknown.

A group of 200 asymptomatic volunteers (eighty-five male, aged 20–65 years) were studied fasting. Exclusion criteria were pregnancy, diabetes mellitus, hypertension (blood pressure >160/90 mmHg), heart failure, any heart valvular disease; and stroke, myocardial infarction or angina within 3 months. Arterial endothelial function was assessed by recording minute by minute changes in brachioradial pulse wave velocity (PWV) during reactive hyperaemia induced by release of a standard sphygmomanometer cuff inflated to supra-systolic pressure at the wrist for 5 min. PWV is inversely proportional to distensibility, and flow-mediated, endothelium-dependent vascular smooth muscle relaxation leads to a reduction in local arterial PWV. Venous blood was drawn without stasis from an antecubital vein into tubes containing lithium heparin and was separated immediately by refrigerated centrifugation, and then frozen at −70° until assay.

Endothelial function was calculated as average percentage change in PWV in the first 5 min after release of cuff occlusion, and correlated against plasma fatty acid content. Increasing di-homo-gamma-linolenic acid (C20:3*n*-6, DHGL) and arachidonic acid (C20:4*n*-6, AA) levels were significantly correlated with worsening endothelial function (*r* –0.17, *P* 0.025; *r* –0.21, *P* 0.004, respectively). There were no significant correlations between ALA, EPA or DHA content and endothelial function.

Thus higher fasting plasma DHGL and AA content in a healthy population are associated with impaired vasodilator response to increased flow. The metabolic pathway of sequential chain elongation and desaturation of the *n-6* series prostanoids with more vasoconstrictor effects than those from the *n-3* series. The relative proportions of *n-3* to *n-6* PUFA in human diet may have implications for vascular health.

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Effect of flavour enhancers on food intake in hospitalized elderly patients in Hong Kong. By C.J.K. HENRY[1], T.A. SEYOUM[1], H.J. LIGHTOWLER[1] and J. WOO[2], [1]*Nutrition and Food Science Group, School of Biological and Molecular Sciences, Oxford Brookes University, Gipsy Lane Campus, Headington, Oxford, OX3 0BP and* [2]*Chinese University of Hong Kong, Prince of Wales Hospital, Shatin, New Territories, Hong Kong*

China represents two-fifths of the world's total population. Moreover, the Chinese elderly population appears to be increasing at a faster rate than in most other countries. Although the proportion of the Chinese population aged 65+ years is not very high now (5.6% in 1990 compared with 15.7% in the UK), it is predicted that by 2050 the proportion of elderly Chinese will increase to 22.6% – a total of 334 million elderly (Yi & George, 2000).

Previous research suggests that the elderly are at an increased risk of morbidity, mainly due to poor food intake caused by a decline in sensory perception, poor dentition, lack of appetite and medication (Rolls, 1993). Little is known about energy and nutrient intakes in the Hong Kong Chinese elderly, especially among hospitalized patients. The aim of this study was to investigate the effect of flavour enhancers on food intake in hospitalized elderly patients in Hong Kong.

Three male and five female elderly patients, mean age 80 (SD 11.4) years, took part in the study. Serial measurements of food and nutrient intake were taken. For each subject, food intake was weighed during a control day and four experimental days. For the experimental days, four flavour enhancers (average 1%) were added to foods in a randomized order determined by a Latin square design. Energy and protein intakes were analysed using Diet5 for Windows and the 'Nutrient Composition of Malaysian Food' (Siong, 1985).
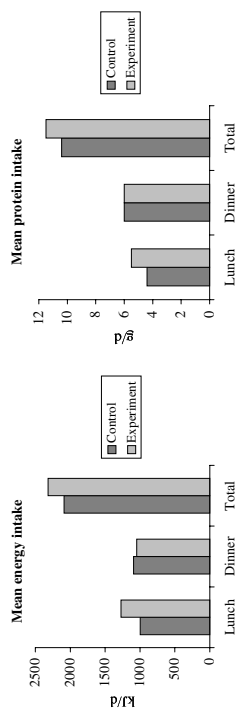
For the control day, total food intake was 514 g (lunch 244 g and dinner 270 g). Mean total daily food intake for the experimental days was increased by 7% to 548 g (lunch 270 g and dinner 278 g). Energy intake at lunch was increased by 28%; overall, the use of flavour enhancers increased energy intake by 11%. In addition to increasing energy intake, flavour enhancers also increased protein intake: at lunchtime there was a 25% increase in protein intake; overall, protein intake was increased by 11%.

Although not statistically significant, findings from this preliminary study suggest a role for flavour enhancers in the elderly. Further work to investigate the long-term effect of flavour enhancers on food intake in the elderly is now required.

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