Proceedings of the Nutrition Society

Abstracts of Original Communications

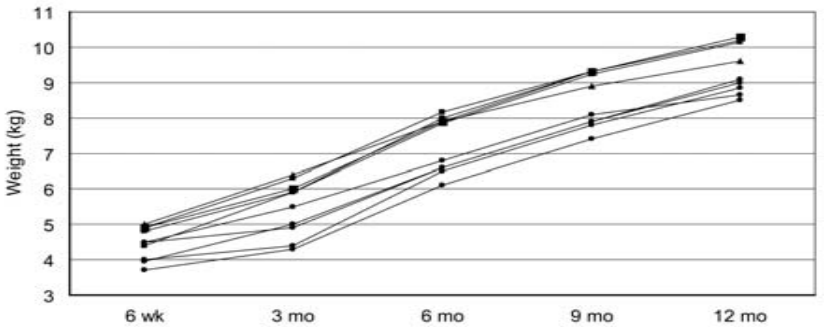
A Scientific Meeting was held at Churchill College, Cambridge, UK, 11–13 December 2006, when the following papers were presented.

All abstracts are prepared as camera-ready material.

The growth and feeding of babies 100 years ago: implications for retrospective studies of infant nutrition and adult health. By L.T. WEAVER[1] and A. FERGUSON[2], [1]*Division of Developmental Medicine and* [2]*Centre for History of Medicine, University of Glasgow, Glasgow G128QQ, UK*

There is much interest in the relationship between birth weight and infant growth and risk of chronic disease in later life. Studies that have sought a significant relationship between anthropometric indices and growth patterns in early life and later outcomes have adopted a variety of subjects and designs, including domestic, farm and laboratory animals and infants born preterm, of low birth weight, twins and with different genotypes. A significant and influential number of such studies have been retrospective, based on measures of body size and growth in infancy obtained from archival records of the first few decades of the 20th century. However, there are few systematically obtained 'normal' data from this period, not just concerning serial anthropometry, but also documenting infant feeding regimens. Without such data it is difficult to interpret the purported relationship between early-life anthropometric and nutritional status and later outcomes. The aims of the present study were to obtain such data from contemporary published sources, and to test current hypotheses about the early origins of adult disease.

Data (EARLY (●)) from infant clinics in France and England published by Pritchard (1904), Newman (1906), Budin (1907), Variot & Flanniaux (1914) and Robertson (1916) were examined. These EARLY data were collected from babies that were largely healthy, 'normal' and breast-fed. They were compared with 'modern' growth references (RECENT (■)) for male infants, including Tanner & Whitehouse (1973), Gairdner & Pearson (1988), Wright *et al*. (2002), National Center for Health Statistics (2000). Both data sets were compared with World Health Organization (2006) standards based on healthy breast-fed male infants (▲).



Mean weights of EARLY infants ascended the lower centiles of modern growth references. At 1 year they were all ≥1 kg lower than those for RECENT infants ($P<0.001$). The difference in growth rates between EARLY and RECENT infants is apparent from 3 months; the former are on average ≥1 kg lighter thereafter ($P<0.001$). EARLY data (Variot & Flanniaux, 1914) and historical records show that throughout the first year breast-fed infants grew faster than artificially-fed babies. Even taking into account that not all EARLY data distinguished girls from boys, they support the hypothesis that it is mode of feeding and not body weight that is the principal risk factor for later chronic disease, and accord with the growing view that breast-feeding is 'protective' of later disease through its effect on growth trajectory (Weaver, 2006).

Budin P (1907) *The Nursling* [WJ Maloney, translater]. London: Caxton.
Gairdner D & Pearson J (1988) *Archives of Disease in Childhood* **60**, 1202.
National Centre for Health Statistics (2000) www.cdc.gov/growthcharts
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Pritchard E (1904) *The Physiological Feeding of Infants*. London: Kimpton.
Robertson TB (1916) *American Journal of Physiology* **41**, 535–546.
Tanner & Whitehouse (1973) *Archives of Disease in Childhood* **48**, 7886–7889.
Wright CM, Booth IW, Buckler JMH et al (2002) *Archives of Disease in Childhood* **86**, 11–14.
Variot G & Flaniaux N (1914) *Comptes Rendus Academie des Sciences (Paris)* **158**, 1361–1364.
Weaver LT (2006) *Journal of Pediatric Gastroenterology and Nutrition* **43**, 428–432.
World Health Organization (2006) www.who.int/childgrowth/standards

Dietary patterns in infancy: results from the Southampton Women's Survey (SWS). By S. ROBINSON, L. MARRIOTT, J. POOLE, S. CROZIER, S. BORLAND, W. LAWRENCE, C. LAW, C. COOPER, H. INSKIP and THE SWS STUDY GROUP, *MRC Epidemiology Resource Centre, University of Southampton, Southampton General Hospital, Southampton SO16 6YD, UK*

It is not known what constitutes an optimal diet in infancy, i.e. a diet sufficient in amount and quality to meet nutrient requirements and to allow an infant to grow and develop to its potential. The most recent national survey of infant feeding in the UK indicates wide variations in practice (Hamlyn *et al*. 2002), but whether these differences have implications for current or future health is unknown. There is a need for prospective investigations of the effect of diet and nutrition of infants on health in later life.

The dietary patterns of a general population sample of infants who were born to women in the SWS are described. The SWS, which was started in 1998, is a study of a population sample of 12 500 non-pregnant women aged 20–34 years resident in the city of Southampton, UK (Inskip *et al*. 2006). The aim of the SWS is to identify the maternal influences that act before and during pregnancy that determine fetal growth. Babies born to women in the SWS are followed up at 6 and 12 months of age. Infant diet is assessed using administered FFQ. At 6 months the FFQ records the average frequency of consumption and amounts of thirty-four foods over 1 week preceding the interview. At 12 months the FFQ records the frequency and amounts of seventy-eight foods consumed over 1 month preceding the interview. Portion size is described using household measures and food models. Frequencies of consumption and amounts of foods not listed on the FFQ are recorded if consumed once or more per week. There were 1973 singleton births to women in the SWS up to the end of 2003. Complete dietary data were available for 1434 of these infants (73%) at both 6 and 12 months of age. Dietary patterns were defined using principal components analysis.

At 6 months three dietary patterns were identified. The first was characterised by high consumption of home-prepared foods and breast milk, but by low consumption of commercial baby foods and formula milk ('infant guidelines' pattern). The second pattern was characterised by high consumption of bread, savoury snacks, biscuits and chips, but by low consumption of breast milk and baby rice ('adult foods' pattern). The third pattern was characterised by high consumption of 'wet' commercial baby foods, but by low consumption of dried commercial baby foods ('baby jar foods' pattern). At 12 months two dietary patterns were identified that were similar to the first two patterns defined at 6 months (labelled '12-month infant guidelines', '12-month adult foods'). The pattern scores were correlated at 6 and 12 months (r 0.48, 'infant guidelines'; r 0.44, 'adult foods'), indicating tracking of these patterns in late infancy. These dietary patterns reflect wide variations in contemporary weaning practice. Their importance for growth and development, and long-term outcomes, needs to be investigated.

This work was supported by the Medical Research Council, University of Southampton, British Heart Foundation and the Food Standards Agency (contract no. N05049).

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Inskip HM, Godfrey KM, Robinson SM, Law CM, Barker DJ & Cooper C (2006) *International Journal of Epidemiology* **35**, 42–48.

Comparison of infant feeding practices in five European centres. By J.A. SCOTT[1], I. CHATZIIOANNIDIS[1], S. HIGGINS[1], F. BENATTI[2], A. UUSIJARVI[3], J. MALDONADO[4], M. TOTZAUER[5] and C.A. EDWARDS[1] and other members of the INFABIO team, [1]*Human Nutrition Section, University Division of Developmental Medicine, Glasgow Royal Infirmary, Glasgow G31 2ER, UK,* [2]*Department of Paediatrics, University of Modena and Reggio-Emilia, Modena, Italy,* [3]*Karolinska Institute, Stockholm, Sweden,* [4]*Department of Paediatrics, University of Granada, Granada, Spain and* [5]*Department of General Paediatrics, University Children's Hospital, Düsseldorf, Germany*

Diet and environment in the first year of life are critical factors in the health of the infant but are also of importance in determining long-term gut function and immune response of the child and adult. While the prevalence of allergy is increasing in Europe there are geographical variations in the risk of allergy, which may be explained by differences in dietary and environmental exposures in infancy. The INFABIO project is an EU-funded project designed to use the diversity of infant feeding and environmental influences in selected northern and southern European countries to identify factors determining the development of gut bacterial metabolism and potential biomarkers for the risk of infant allergy and infection.

Data on infant feeding and environmental influences during the first 12 months of life were collected in a longitudinal study of 781 infants from five European centres: Glasgow (UK), Granada (Spain), Düsseldorf (Germany), Stockholm (Sweden), Modena (Italy). Survival analysis was used to determine 'time to event' for selected infant feeding practices such as duration of breast-feeding, age of introduction of solids and age of introduction of cow's milk as a drink. While the majority of mothers initiated breast-feeding there were significant differences between the centres in the incidence of breast-feeding. Breast-feeding initiation was virtually universal in Stockholm and Modena but in Glasgow only 58% of infants were ever breast-fed. It is recommended that all infants be exclusively breast-fed until about 6 months of age. However, less than half all infants were receiving any breast milk at this age, and again there were marked differences between centres in the prevalence of breast-feeding at 6 months. Most infants had received solid foods before 6 months of age, with the median age of introduction in all centres, with the exception of Düsseldorf, being 16 or 17 weeks. With the exception of Granada, the majority of infants in all centres had received cow's milk as a drink before 12 months.

INFABIO centre	*n*	Ever breast-fed (%)	Prevalence of breast-feeding at 6 months (%)	Median duration of any breast-feeding* (weeks)	Median age of introduction of solids (weeks)	Cow's milk as a drink before 12 months (%)
Glasgow	161	58	32	29	16	67
Granada	147	80	27	23	16	20
Düsseldorf	223	86	52	33	22	49
Stockholm	123	100	85	51	17	60
Reggio-Emilia	127	99	43	21	17	75
Total	781	84	47	29	17	52

*For those infants who were breast-fed.

Analysis of the INFABIO infant feeding data revealed that the majority of infants in the study centres were not fed in accordance with current international recommendations. There was also considerable disparity between the centres in the duration of breast-feeding and the age at which solids and cow's milk as a drink were first introduced.

This work (Project QRLT 2002 02606; INFABIO) was carried out with financial support from the EC. It does not necessarily reflect its views and in no way anticipates the EC's future policy in this area.

Representation of early nutritional programming in policy documents on infant nutrition: comparison of five European countries. By T. DECSI[1], S.Z. BOKOR[1], E. MARTIN-BAUTISTA[2], C. CAMPOY[2], K. LAITINEN[3], J. VON ROSEN-VON HOEWEL[4], M.A. SCHMID[5], H. GAGE[5], B. KOLETZKO[4], J. MORGAN[5] and M.M. RAATS[5], [1]*Department of Paediatrics, University of Pécs, Hungary,* [2]*Department of Paediatrics, University of Granada, Spain,* [3]*Department of Biochemistry and Food Chemistry, University of Turku, Finland,* [4]*Dr von Hauner Children's Hospital, Ludwig-Maximilians University, Munich, Germany and* [5]*Food, Consumer Behaviour and Health Research Centre, University of Surrey, Guildford GU2 7XH, UK*

The concept that early nutrition may exert programming effects on long-term health has been widely accepted in nutritional sciences. However, the extent to which this concept has been integrated into policy recommendations on infant nutrition is not known. The frequency and content of programming statements in available documents in five European countries was reviewed.

Documents were located through a search of printed materials and websites of relevant organisations using the key words: nutrition; diet; breast-feeding; bottle feeding; formula feeding; weaning; complementary feeding; infant feeding; baby. The search was carried out between July and October 2005. Policy documents that contained recommendations, guidelines and information for professionals about feeding healthy infants aged 0–12 months from national and regional government bodies, professional colleges and associations, retail and manufacturing industries and special interest groups were included. Documents targetting non-healthy infants, reviews and research reports were disregarded.

Altogether thirty-eight policy documents were identified (England, 10; Finland, 2; Germany, 11; Hungary, 8; Spain, 7) and screened for short (<5 years)-, medium (5–15 years)- and long (>15 years)-term effects of nutrients, foods and feeding behaviour on infant health outcomes, i.e. nutrition programming statements. Statements on non-nutritive substances (e.g. alcohol and all toxicological substances) as well as non-feeding-related behaviour (e.g. smoking) were excluded.

Altogether 455 statements were identified; and categorized into fifty-three different health outcomes. The eight most frequently mentioned categories are listed together with the cumulative number of their occurrence in the national policy documents in the table.

	England		Finland		Germany		Hungary		Spain		All	
Health outcome categories	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Allergy, atopic disease	8	7.4	3	11.5	31	17.4	16	24.6	6	7.7	64	14.1
Health used as a general term	12	11.1	0	0.0	11	6.2	3	4.6	0	0.0	26	5.7
Obesity, overweight	5	4.6	1	3.8	10	5.6	4	6.2	5	6.4	25	5.5
Gastrointestinal infection (diarrhoea)	7	6.5	1	3.8	5	2.8	3	4.6	6	7.7	22	4.8
Development (as general term)	5	4.6	1	3.8	11	6.2	4	6.2	1	1.3	22	4.8
Growth (as general term)	9	8.3	1	3.8	7	3.9	0	0.0	4	5.1	21	4.6
Cognitive (mental) development	2	1.9	5	19.2	9	5.1	4	6.2	1	1.3	21	4.6
Infection without specification	3	2.8	2	7.7	7	3.9	3	4.6	5	6.4	20	4.4
All fifty-three health outcome categories	108		26		178		65		78		455	

Approximately half the statements (*n* 229, 51.5%) did not mention the duration of the programming effect. Where mentioned, 118 (25.9%) referred to short-term effects, 39 (8.6%) to medium-term effects and 69 (15.5%) to long-term effects. Less than half the statements (*n* 195, 43.8%) referenced supportive evidence, but with considerable variation across countries: Finland (*n* 13, 50.0%), Germany (*n* 43, 24.2%), Hungary (*n* 4, 6.2%), Spain (*n* 73, 93.6%) and England (*n* 62, 57.4%). The strength of evidence was also evaluated according to evidence-based medicine standards.

In summary, policy documents on infant nutrition in different European countries include many statements on programming effects but these statements are not always supported by reference to the evidence-base. There is considerable variation across countries as to the specific nature of the health outcomes being addressed. Where specified, the duration of the health effects referred to was more often short term rather than long term.

BeWo cells as an *in vitro* model for iron transport across the placenta. By S.J. HEATON[1], J.J. EADY[1], S.J. FAIRWEATHER-TAIT[1], H.J. MCARDLE[2], K.S. SRAI[3] and R.M. ELLIOTT[1], [1]*Institute of Food Research, Norwich Research Park, Colney, Norwich NR4 7UA, UK,* [2]*Rowett Research Institute, Aberdeen AB21 9SB, UK and* [3]*University College London, London WC1E 6BT, UK*

When grown on permeable membrane inserts, the b30 clone of placental trophoblast BeWo cells form polarized monolayers, making them a convenient model for the study of placental transport mechanisms (Danzeisen *et al*. 2000). Receptor-mediated uptake and release of Fe is a property of this model system that has not previously been investigated. The aim of the present work was to characterize the properties of the cell line before going on to study molecular mechanisms underlying the regulation of Fe transport and interactions with other metals, including Cu.

Cells were seeded onto inserts and transepithelial electrical resistance (TEER) measured using a hand-held voltometer. TEER increased with time post seeding (Table); on day 7 measurements reached approximately 340–380 Ωcm^2, at which point cells were considered to be confluent. Once the cells had reached confluence, transferrin-bound ^{55}Fe was added (0.5 μCi/ml and 10 mM-$FeCl_3$) to the apical side of the cells so that Fe retention by cells (intracellular) and efflux (export across the basolateral membrane) could be measured over time. Under these conditions Fe efflux (Figure) and retention (data not shown) were linear in BeWo cells up to 8 h.

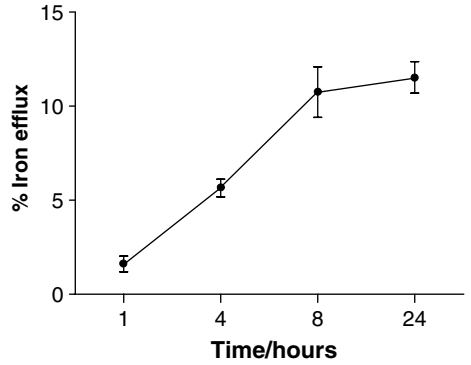

Fig. Iron efflux in BeWo cells over time. Values for total added iron transferred to basolateral side are means with SE (*n* 4).

Table. TEER measurements.

Period post seeding (d) ...	3	4	5	6	7
TEER (Ωcm^2) Average	140	232	250	310	355
SD	5.0	3.1	6.4	3.6	5.6

The data indicate that the b30 clone of BeWo cells is very efficient at exporting Fe; Fe efflux was approximately 10% compared with 1.5% retention after 8 h. This data contrasts with the $CaCo_2$ intestinal cell line in which the Fe retained within the cell normally exceeds efflux. The high Fe-exporting property of the BeWo cells suggests they represent a valuable model for Fe transport studies.

Following observations by Danzeisen *et al*. (2002) that an oxidative step is necessary for Fe efflux and 20% O_2 may allow non-enzymic oxidation of Fe^{2+}, bypassing normal cellular mechanisms, experiments were carried out in 5% (v/v) O_2. No significant difference between the treatments in the percentage of Fe efflux was found, but the 5% (v/v) O_2 mimics physiological conditions and this treatment was therefore selected for the model system.

Further experiments are planned to enable the Fe transport properties of the BeWo cells to be characterized, including the analysis of directional regulation of Fe transport through the monolayer.

Sarah Heaton is registered for a PhD at the University of East Anglia. This work is supported by the Biotechnology and Biological Sciences Research Council and Scottish Executive Environment and Rural Affairs Department.

Danzeisen R, Fosset C, Chariana Z, Page K, David S & McArdle HJ (2002) *American Journal of Physiology* **282**, C472–C478.
Danzeisen R, Ponnambalam S, Lea RG, Page K, Gambling L & McArdle HJ (2000) *Placenta* **21**, 805–812.

Measurement of physiologically-available iron in plasma by HPLC following sample preparation by ultrafiltration or solid-phase extraction. By K.J. COLLARD, *School of Health Professions, University of Plymouth, Millbrook House, Topsham Road, Exeter EX2 6ES, UK.*

Oxidative stress mediated by Fe released from transfused erythrocytes may play a role in the development of chronic lung disease (CLD) of prematurity and retinopathy of prematurity (ROP; Dani *et al*. 2001; Collard *et al*. 2005). In order to examine this possible role further, a sensitive and specific method of measuring physiologically-active (non-protein-bound) Fe, particularly Fe^{2+} in body fluids, is required. This study used chromophores, which specifically bind Fe^{2+} or both Fe^{2+} and Fe^{3+} in order to evaluate methods of extracting and measuring plasma Fe by HPLC with spectrophotometric detection. The chromophore used for measuring both Fe^{2+} and Fe^{3+} was 1,2-dimethy-3-hydroxy-4-(1H)-pyridone (DHP), and for Fe^{2+} only 3-(2-pyridyl)-5,6-di(2-furyl)-1,2,4-triazine disulfonic acid (PFS) was used. The HPLC system was polyetheretherketone (PEEK) or PEEK lined. The mobile phase was similar for both chromophores: for PFS, 5.0 mM-PIPES buffer, pH 7.0, containing 1.0 mM-PFS and 4% (v/v) acetonitrile; for DHP, 5.0 mM-PIPES buffer, pH 7.0, containing 5.0 mM-DHP and 5% (v/v) acetonitrile. The mobile phase was pumped at 1.0 ml/min through a 100×4.6 mm C18 column (HI-3.5C18–100A Hichrom, Theale UK). Peaks were quantified using a Dionex 170S UV/VIS detector operated by Chromeleon software (Dionex, Camberley UK) at wavelengths of 450 nm for DHP and 595 nm for PFS. The limit of sensitivity for both methods was <100 nM.

Plasma obtained from adult volunteers, for which appropriate ethical approval had been obtained, was used in this study. The extraction of free unbound and non-specifically-bound Fe from plasma using the Fe chelator nitrilotriacetic acid (NTA 80 mM; Singh *et al*. 1990) demonstrated that the reaction between DHP and Fe was unaffected by NTA; however, the reaction between Fe^{2+} and PFS was disrupted (Table 1). This was probably due to chelation or to the oxidation of Fe^{2+} to Fe^{3+}.

Table 1

Chromophore	Sample	[Fe μM] No NTA	[Fe μM]+NTA	
DHP	5 μM Fe^{3+} in saline	5.038±0.561	5.375±0.299	N.S (n=5)
DHP	Adult plasma	2.07±0.18	2.15±0.22	N.S (n=5)
PFS	5 μM Fe^{2+} in saline	5.022±0.52	0.095±0.023	P<0.001 (n=5)

PFS, while able to react with Fe^{2+} in plasma and produce a signal when extracted, was unable to pull significant amounts of Fe^{2+} from non specific binding to albumin so is only capable of measuring free non-protein bound Fe^{2+}. However, since the iron-binding activity of plasma albumin may have important antioxidant function in newborns (Loban *et al*. 1997), it may be more physiologically relevant to measure the free levels.

Both DHP complexed iron and PFS complexed Fe^{2+} may be extracted from plasma either by filtration using Whatman Vectaspin Micro (Fisher Scientific, Poole UK) tubes or by solid phase extraction using Sep Pak tC_{18} cartridges (Waters, Elstree UK). The extraction of the Fe-DHP complex from plasma of a group of 5 exercising subjects (80% VO_2 max) provided values of 14.135±3.629 μM using Sep Pak and 15.556±4.349 μM using Vectaspin. These methods have been developed using adult plasma. They should be applicable to neonatal plasma and should contribute to the evaluation of the relationship between blood transfusion, iron, oxidative stress, CLD and ROP in premature babies.

This work was supported by The Northcott Devon Medical Foundation.

Collard KJ, Godeck S & Holley JE (2005) *Pediatric Pulmonology* **39**, 257–261.
Dani C, Reali MF, Bertini G, Martelli E, Pezzati M & Rubaltelli FC (2001) *Early Human Development* **62**, 57–63.
Loban A, Kime R & Powers H (1997) *Clinical Science* **93**, 445–451.
Singh S, Hider RC & Porter JB (1990) *Analytical Biochemistry* **186**, 320–323.

Plasma carnitine concentrations and carnitine ester profiles in children with coeliac disease. By G.C. TALIÁN[1], B. MELEGH[1], V. JAKOBIK[2], A. TÁRNOK[2] and T. DECSI[2], [1]*Institute of Genetics and Child Development and* [2]*Department of Paediatrics, University of Pécs, Pécs, Hungary*

The possibility that secondary carnitine deficiency may complicate coeliac disease was put forward by two studies. Lerner *et al*. (1993) have found significantly lower serum total carnitine concentrations in children with coeliac disease than in controls. More recently, significant reduction in plasma concentrations of twelve carnitine esters including acetyl-, propionyl-, butyril-, myristoyl-, myristoleyl- and oleylcarnitine as well as six medium-chain carnitine esters have been reported in adult patients with coeliac disease (CP; Bene *et al*. 2005). As secondary carnitine deficiency may impair lipid metabolism and growth in childhood, plasma carnitine profiles in children with coeliac disease has been investigated.

Twenty-one CP and twenty healthy age-matched control children (age 13.43 (SE 0.850 and 13.61 (SE 0.77) years respectively) were investigated. Children with endocrine disorders or with a history of any metabolic disease, including those with impairment of glucose and lipid metabolism, were excluded from the study. Basic anthropometric data did not differ between CP and controls (weight 48.55 (SE 3.68) kg and 47.33 (SE 2.39) kg; height 1.61 (SE 0.04) m and 1.55 (SE 0.03) m; BMI 18.03 (SE 0.68 kg/m^2 and 19.32 (SE 0.49) kg/m^2 respectively). Plasma anti-endomysium antibodies (EMA) were used to characterise disease activity. The method used for measuring plasma carnitine profiles has been recently described in detail (Bene *et al*. 2005).

No differences were found between CP and controls in plasma free and total carnitine concentrations (μmol/l; Table). Neither the concentrations of the twelve acylcarnitines that were found to be reduced in adult CP, nor the concentrations of other twelve acylcarnitines, differed between CP and controls (values for the three short- and three long-chain acylcarnitines that were found to be significantly reduced in adult CP are shown in the Table). Lerner *et al*. (1993) have reported significantly lower serum carnitine concentrations in CP with damaged intestinal mucosa than in CP with normal mucosa. In the present study no significant difference in carnitine profiles between EMA-positive (EMA+) and EMA-negative (EMA–) CP was found (Table).

	Controls (*n* 20)		CP (*n* 21)		CP EMA+ (*n* 9)		CP EMA– (*n* 10)	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Free carnitine	28.986	1.692	27.549	1.167	30.171	2.141	26.027	1.128
Acetylcarnitine (C_2)	17.899	1.237	18.061	1.003	18.643	1.714	17.594	1.420
Propionylcarnitine (C_3)	0.257	0.019	0.245	0.013	0.271	0.026	0.226	0.014
Butyrylcarnitine (C_4)	0.523	0.025	0.543	0.027	0.546	0.028	0.511	0.047
Myristoylcarnitine (C_{14})	0.024	0.002	0.022	0.002	0.027	0.003	0.020	0.002
Myristoleylcarnitine (14:1)	0.043	0.005	0.041	0.006	0.037	0.007	0.051	0.011
Oleylcarnitine (18:1)	0.140	0.008	0.135	0.017	0.166	0.029	0.122	0.020
Total carnitine esters	20.649	1.316	20.794	1.112	21.631	1.926	20.178	1.548
Total carnitines	49.635	2.530	48.344	1.964	51.803	3.495	46.205	2.309

In summary, clinically-stable children suffering from coeliac disease did not show biochemical signs of secondary carnitine deficiency in the present study, even if the presence of plasma anti-EMA indicated less than strict adherence to the diet. It remains to be clarified which nutritional status might be associated with abnormalities of carnitine metabolism in coeliac disease.

Bene J, Komlósi K, Gasztonyi B, Juhász M, Tulassay Zs & Melegh B (2005) *World Journal of Gastroenterology* **11**, 6671–6675.
Lerner A, Gruener N & Iancu TC (1993) *Gut* **34**, 933–935.

Infant growth and later body composition: evidence from the four-component model. By S. CHOMTHO, J.C.K. WELLS, J.E. WILLIAMS and M.S. FEWTRELL, *MRC Childhood Nutrition Research Centre, Institute of Child Health, London WC1N 1EH, UK*

Several publications investigating postnatal growth and later outcomes have demonstrated a positive relationship between rapid infancy and childhood weight gain and higher BMI in childhood and adult life (Stettler *et al.* 2003; Ong *et al.* 2000). A limited number of recent publications that have measured fat mass (FM) and fat-free mass (FFM) separately have reported inconsistent associations between postnatal growth and these individual components (Wells *et al.* 2005; Ekelund *et al.* 2006). No study has so far used the four-component (4C) model of body composition (BC) to investigate this issue.

Healthy full-term UK children and adolescents (*n* 191, eighty-eight boys; mean age 11.8 (SD 3.8) years) were studied. Fifty-two had early growth data documented prospectively as a part of an infant nutrition study and 139 participated in a BC reference study at the same centre; their early growth data was collected from parent-held baby record books. Infant weight SD score (SDS) at different ages were calculated using the British 1990 reference (Cole *et al.* 1998). Outcomes measured were total FM and FFM, which were assessed by the 4-C model and regional FM, which was assessed by dual-energy X-ray absorptiometry. FM index (FMI, FM/height^2) and FFM index (FFMI, FFM/height^2) SDS were calculated using the authors' reference data by the LMS method (Cole, 1990). Regression of BC outcomes *v*. change (Δ) in weight SDS in infancy with adjustment for birth weight SDS and potential confounders was carried out (only those with infant weight gain data were included).

Of the children thirty-five (18.3%) and six (3.1%) respectively were overweight or obese. Mean BMI SDS was 0.10 (SD 1.32) in boys and 0.31 (SD 1.11) in girls. Δ Weight SDS for 6–12 weeks and 3–6 months showed a significant positive association with FMI SDS but not FFMI SDS; the effect size was equivalent to a 0.33 SDS (95% CI 0.01, 0.66) and 0.32 SDS (95% CI 0.05, 0.59) increase in later FMI per 1ΔSDS increases in early weight respectively. Higher Δ weight SDS for 6–12 weeks and 3–6 months was associated with a tendency for central fat distribution as assessed by trunk FMI. Δ Weight SDS for 6–12 months was not associated with BC outcomes.

Regression of current body composition *v*. Δ weight SDS during different periods in infancy*

	Δ Weight SDS at ...											
	0–6 weeks (*n* 150)			6–12 weeks (*n* 157)			3–6 months (*n* 150)			6–12 months (*n* 125)		
Later BC	B	SE	*P*	B	SE	*P*	B	SE	*P*	B	SE	*P*
BMI SDS	0.18	0.13	0.18	0.45	0.20	0.03	0.41	0.17	0.02	0.02	0.18	0.93
FMI SDS	0.17	0.11	0.11	0.33	0.17	0.05	0.32	0.14	0.02	−0.01	0.15	0.93
FFMI SDS	0.08	0.11	0.46	0.13	0.18	0.46	0.21	0.15	0.16	0.07	0.16	0.64
Trunk FMI SDS	0.20	0.11	0.06	0.48	0.18	0.01	0.36	0.14	0.01	0.01	0.15	0.98

B, the coefficient of Δ weight SDS, i.e. the change in current BC per early Δ weight SDS. * From multiple regression analysis, each row represents a different model with current BC as a dependent variable; Δ weight SDS was an independent variable; birth weight SDS, gender, pubertal stage, physical activity, social class, ethnicity and parental BMI were covariates.

More rapid weight gain during early infancy (0–6 months), which has also been shown to be associated with adverse cardiovascular outcomes, was associated with later FMI and central fat distribution. These associations were independent of birth weight, current body size, gender, age, pubertal stage, physical activity, social class, ethnicity and parental BMI.

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Vitamin D and linear growth: cohort study on long-term effects of rickets and large-dose supplementation. By E. HYPPÖNEN[1], M. FARAROUIEI[2], C. ROBERTSON[3] and M.R. JÄRVELIN[2], [1]*Centre for Paediatric Epidemiology and Biostatistics, Institute of Child Health, 30 Guilford Street, London WC1N 1EH, UK,* [2]*Department of Epidemiology and Public Health, Imperial College, London, UK and* [3]*Department of Human and Health Sciences, University of Westminster, London, UK*

There is clearly a need for more robust evaluation of the influence of vitamin D on linear growth given that the Food and Nutrition Board, Institute of Medicine (1997) documents a potential adverse influence for vitamin D intakes >45 μg/d based entirely on an uncontrolled case study involving nine children (Jeans & Stearns, 1938). In Finland the official vitamin D recommendation in the mid-1960 s was 50 μg/d (Hallman *et al*. 1964). Data from 10 064 singleton participants in the Northern Finland Birth Cohort 1966 is used here to investigate whether vitamin D supplementation during the first year of life was associated with linear growth. This birth cohort consists of all children from the two northern-most provinces of Finland who were due to be born in 1966 (recruited during visits to antenatal clinics, 24th to 26th week of gestation, Rantakallio P 1969). Information on frequency and dose of vitamin D supplementation and data on suspected rickets was collected by a questionnaire in 1967 when the participants were aged 1 year. Weights and heights were measured, and information on social background factors collected, at birth, 1 year, 14 years and 31 years.

Compliance with supplementation recommendations was good, with 83 % receiving the recommended 50 μg vitamin D/d regularly during the first year of life. Only thirty-two individuals (0.3 %) received no supplementation and 208 participants (2.1 %) were suspected of having had rickets. An association between frequency of vitamin D supplementation (but not dose) with greater height at age 1 year was evident (P=0.003, Table). However, this association was not apparent after adjustment for maternal size, birth characteristics and social indicators (P=0.23). Neither frequency nor dose of vitamin D supplementation were associated with height at 14 or 31 years (P>0.05 for all comparisons). Adjustment for maternal size, birth characteristics or social indicators did not affect the associations between vitamin D supplementation and height. There were no differences in height at any age between participants suspected of having had rickets and other participants; however, those participants with rickets were somewhat lighter compared with other participants at 1 year (10.2 kg *v*. 10.3 kg; P=0.01, adjusted for maternal size, birth characteristics and social indicators).

These results suggest that neither vitamin D deficiency nor supplementation with large doses had adverse long-term influences on linear growth.

Table. Average height (m) by vitamin D supplementation and rickets during the first year.

			1 year		14 years		31 years	
	n	%	Mean	SD	Mean	SD	Mean	SD
Frequency of vitamin D supplementation								
None	32	0.32	0.754*	0.030	1.627	0.083	1.673*	0.100
Irregularly	1170	11.63	0.757	0.029	1.631	0.081	1.715	0.095
Regularly	8862	88.06	0.759	0.029	1.631	0.078	1.713	0.092
Dose of vitamin D (μg/d)†								
<50	69	0.78	0.758	0.028	1.633	0.068	1.706	0.090
50	8340	94.48	0.758	0.029	1.631	0.078	1.713	0.091
>50	418	4.74	0.759	0.030	1.644	0.082	1.708	0.094
Suspected rickets								
No	9856	97.93	0.758	0.029	1.631	0.078	1.713	0.092
Yes	208	2.07	0.759	0.031	1.635	0.083	1.729	0.097

*P<0.01 for differences by frequency groups after adjustment for age and gender . † Data shown for participants who received vitamin D supplementation regularly, information on dose missing for 35 participants.

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Birth weight and infant growth in The Gambia are not significantly related to maternal plasma 25-hydroxyvitamin D concentration during pregnancy. By A. PRENTICE, L.M.A. JARJOU, J. BENNETT, H. OLAUSSON, M.A. LASKEY, I. SCHOENMAKERS and G.R. GOLDBERG, *MRC Human Nutrition Research, Elsie Widdowson Laboratory, Fulbourn Road, Cambridge CB1 9NL, UK and MRC Keneba, PO Box 273, The Gambia*

Associations have been reported between maternal vitamin D status and the growth and bone mineral accrual of the offspring in populations for whom poor vitamin D status is common (Prentice, 2003; Javaid *et al*. 2006). Most of these studies have used a circulating 25-hydroxyvitamin D (25OHD) concentration of 25 nmol/l as the lower threshold of normality for vitamin D status. However, there are calls for this definition to be reconsidered upwards, most recently to 80 nmol/l (Hollis & Wagner, 2006). On a population basis mean 25OHD concentrations >80 nmol/l are relatively uncommon in temperate countries, but are observed in the tropics when there are no restrictions on skin sunshine exposure. To investigate whether the associations between fetal and infant growth are evident at 25OHD concentrations well in excess of 25 nmol/l, data were analysed from 125 mothers and infants living in The Gambia, West Africa. These subjects had participated in a study of Ca supplementation in pregnancy in which no significant benefits for fetal and infant growth had been detected despite the low customary Ca intake of the mothers (Jarjou *et al*. 2006). The Gambia, latitude 13°N, has abundant tropical sunshine all year and there are no cultural restrictions on skin sunshine exposure.

The protocol, methods and subject characteristics of the main study have been published (Jarjou *et al*. 2006). Briefly, Gambian women were recruited at 20 weeks of pregnancy (P20) and randomised to a Ca supplement (1500 mg/d) or placebo until delivery. Fasting early-morning blood was collected and anthropometry performed. Plasma 25OHD at P20 was measured using RIA (DiaSorin, Wokingham, Berks., UK), with assay performance monitored through the national quality assurance scheme (Vitamin D External Quality Assessment Scheme; http://www.deqas.org/). Samples from two subjects were not available. Infant birth weight was measured within 24 h of delivery. Weight, crown–heel length and head circumference were measured at <5 d and at 2, 13 and 52 weeks post partum. In addition, at 2, 13 and 52 weeks infant bone mineral content (BMC), bone mineral density (BMD) and scanned bone width (BW), or bone area (BA), were measured by single-photon absorptiometry of the radius (model SP2; Lunar Radiation Corporation, Madison, WI, USA) and, for some in the cohort (*n* 44, 47 and 52 at 2, 13 and 52 weeks respectively), by whole-body dual-energy X-ray absorptiometry (model DPX+; Lunar Radiation Corporation). Relationships between infant growth and maternal 25OHD concentration were explored using multiple linear regression models (DataDesk 6.1; Data Description Inc, Ithaca, NY, USA) in which potential confounders were included (maternal weight, weight gain, height, parity, supplement group, gender of infant, season).

The age, weight, height and parity of the mothers at P20 were 27.4 (SD 7.5) years, 56.3 (SD 6.7) kg, 1.61 (SD 0.54) m and 3.3 (SD 2.7) respectively. Mean 25OHD was 103 (SD 25, range 53–167) nmol/l; 24 % of values were <80 nmol/l. No significant relationships were observed between maternal vitamin D status and any of the following: birth weight, infant weight, height, head circumference, BMC, BMD, BW or BA, size-adjusted BMC of the whole body and mid-shaft radius at any time post partum. Comparing the results for mothers with 25OHD >80 nmol/l and <80 nmol/l did not alter this finding, nor were the results significantly affected by maternal Ca supplementation. It is concluded that there is no evidence for an influence of vitamin D status during pregnancy on infant growth and bone mineral accrual at the maternal 25OHD concentrations prevalent in The Gambia, i.e. >50 nmol/l.

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Comparison of two models of intrauterine growth retardation (IUGR) for studies investigating later diabetes development in rats. By Y. SHAHKHALILI, J. MOULIN, K.J. ACHESON, O. APRIKIAN, I. ZBINDEN and K. MACE, *Nestlé Research Centre, 1000 Lausanne 26, Switzerland*

IUGR resulting in low birth weight is often compensated by accelerated postnatal growth (catch-up growth) and is considered to be an important risk factor for the later development of metabolic diseases such as type 2 diabetes, obesity, hypertension and IHD (Hales *et al*. 1991; Baker *et al*. 1993).

Two models of IUGR, maternal food restriction and gestational hormonal intervention, were compared for later development of obesity and diabetes in rats. Virgin Sprague Dawley (SD) rats of similar body weight and age were single mated for one night. The gestating mothers were randomly divided into three study groups, A, B and C, with similar body weights (six to seven per group) at 10 d of gestation. Group A received half the amount of food consumed by group C (control group) on a daily basis from day 10 to day 20 of gestation. Animals in group B received a daily subcutaneous injection of dexamethasone (100 µg/kg body weight per d) from 15 to 21 d of gestation. Group C was fed *ad libitum* and received no intervention throughout gestation. All animals were fed a rat chow diet (Kliba 3434; Provimi, Cossonay, Switzerland) during the study (except pups during the suckling period).

Body weights of the pups were recorded within 24 h of birth and only dams (two to three per group) and their pups bearing at least eight pups with at least three to four males per litter were selected to continue the study. The number of pups per litter was reduced to eight and they suckled milk until 21 d of age. Male offspring (twelve, ten and seven in groups A, B and C respectively) were then caged individually and were fed *ad libitum* with chow diets until 155 d of age. Food intake, body weight and body composition (by NMR) of the animals were measured during the study (not reported here) and their blood glucose and insulin responses to an intraperitoneal glucose tolerance test (IP GTT) were measured at 8, 16 and 22 weeks of age.

Both maternal interventions significantly reduced the birth weight of pups relative to the control group, with mean reductions of –18 % to –22 % for group A and –20 % to –26 % for group B for genders considered together or separately and selected male pups that continued the study ($P<0.0001$, in all cases). At 8 weeks of age the 2 h area under the glucose curve in response to an IP GTT was significantly higher for group A (15 % higher mean value, n 9), but not for group B (n 8), compared with that for group C (n 5; $P<0.02$). This effect was not statistically significant at the later ages of 16 and 22 weeks. At 22 weeks of age fasting (food deprivation for 6 h during the day) blood glucose was also significantly higher for group A (10 % higher mean value, n 10) relative to that for group C (n 7; $P<0.04$). This effect was not observed for group B (n 9). The fasting plasma insulin concentrations of both treated groups were not statistically different from those for the control group ($P>0.05$) at all ages. The increase in 2 h area under insulin curve in response to an IP GTT was significantly higher for group B (1.5-fold higher median value, n 9) than that for group C (n 7; $P<0.03$) at age of 8 weeks but not at the later ages (16 and 22 weeks).

The results demonstrate that maternal food restriction (50 %) during the last 10 d of gestation has a long-term effect on blood glucose regulation of offspring at adult age (hyperglycaemia) and suggest that food restriction during gestation is a better model than gestational hormonal intervention for rat studies aimed at investigating the later development of glucose intolerance in susceptible SD rats.

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Low-grade inflammatory markers: levels and determinants in a rural West African population. By A.A. DAVIES, S.E. MOORE, A.J. FULFORD and A.M. PRENTICE, *MRC International Nutrition Group, London School of Hygiene & Tropical Medicine, Keppel Street, London WC1E 7HT, UK and MRC Keneba, Medical Research Council Laboratories, The Gambia, Banjul, West Africa*

Low-grade systemic inflammation is a novel characteristic of obesity and a putative causal risk factor for chronic diseases. Programming of this inflammatory status may provide a mechanism to explain the association between poor early-life nutrition and increased risk of adult chronic disease. We characterised levels and determinants of inflammatory status in a healthy rural West African population (previous research has focused on white Caucasian populations) for whom early nutrition remains a health concern.

Cross-sectional data were collected on 180 healthy individuals. Fasted blood was collected and seven inflammatory markers measured. Findings for high sensitivity C-reactive protein (CRP) only are reported here. Adiposity was estimated by body mass index (BMI). The presence of malaria parasites and leucocyte count measured infectious disease status. In participants ≥13 years subclinical chronic disease was characterized by fasting glucose, full lipid profile and blood pressure. Questionnaire data on smoking (≥16 years) and contraceptive use (females aged 13–50 years) were collected.

The Table shows mean CRP concentrations by age-group and gender. All mean CRP concentrations were below the 'normal' cut-off (<4 mg/l). When compared with large-survey data from the USA (Ford *et al*. 2003; Alley *et al*. 2006) Gambians <20 years had higher median CRP concentrations than their US counterparts (mg/l; 1.8 (interquartile range (IQR) 1.4–2.6) *v*. 0.4 (IQR 0.1–1.0)) whilst Gambians ≥20 years had similar levels of CRP (mg/l; 2.0 (IQR 1.5–3.2) *v*. 2.1 (IQR 0.8–4.7)). Geometric mean CRP concentrations were higher in males (see Table) and smokers (2.4 *v*. 2.2 mg/l; $P=0.4$) and significantly higher in those who were overweight (BMI ≥25 kg/m^2; 2.9 *v*. 2.1 mg/l; $P=0.04$). In multiple regression analysis age was the strongest determinant of CRP; an association not explained by gender, BMI, smoking, contraceptive use or disease status.

	Males			Females			
Age (years)	*n*	Mean CRP (mg/l)*	IQR	*n*	Mean CRP (mg/l)*	IQR	*t* test (*P* value)
3–5	10	2.1	1.4–3.0	10	2.0	1.6–2.3	0.9
6–8	10	2.3	1.7–2.6	10	2.4	1.9–2.9	0.7
9–12	10	1.9	1.3–1.7	10	1.7	1.6–1.9	0.6
13–15	10	1.6	1.1–1.5	10	1.7	1.3–2.2	0.7
16–18	10	2.8	1.7–5.5	10	1.5	1.1–1.7	0.02
19–30	10	1.4	1.1–1.8	10	1.9	1.4–2.4	0.07
31–50	10	2.3	1.6–2.8	10	2.2	1.3–2.1	0.8
51–65	10	2.3	1.5–3.1	10	2.3	1.5–3.1	0.9
>65	10	3.7	2.5–4.2	10	2.9	2.0–3.8	0.4
Total	90	2.2	1.5–2.8	90	2.0	1.5–2.5	0.4

*CRP was log transformed for analysis and geometric means presented.

CRP levels in healthy rural Gambian adults were similar to those reported from US survey data. The lack of association between BMI and CRP in the multiple regression analysis may be explained by the relatively-low BMI of the study population. The ability to measure low-grade inflammation in a relatively-lean population supports our current study (ongoing) to investigate the association between early-life events and adult low-grade inflammation independent of current adiposity in a West African population.

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Sources of dietary protein and lipid interact to modify maternal and fetal development in the pregnant rat. By C.J. MCNEIL, C.A. MALONEY, S.M HAY and W.D. REES, *The Rowett Research Institute, Greenburn Road, Bucksburn, Aberdeen AB21 9SB, UK*

Subtle differences in the composition of the maternal diet during gestation can programme glucose metabolism in the offspring. Our previous studies have shown that the protein content of the maternal diet does not affect glucose metabolism in the offspring when the diet contains maize oil, but when it is prepared with soya oil insulin release is greater in the female offspring of dams fed a high-protein diet. Furthermore, insulin-stimulated gene expression of hepatic acetyl-CoA carboxylase (ACC) and carnitine palmitoyl transferase (CPT-1), key genes of lipid metabolism, is also dependent on the oil type used in the diet. The present study investigated maternal and fetal growth and metabolism during gestation in rats fed high- or low-protein diets prepared with maize or soya oil.

Female Rowett Hooded Lister rats were fed four diets containing 180 or 90 g protein/kg and 70 g maize or soya oil/kg (diets 18C, 9C, 18S and 9S respectively) for 2 weeks before mating. The pregnant dams were maintained on these diets until day 21 of gestation when the animals were killed and fetal and maternal organs were dissected and weighed. Concentrations of glucose and TAG in the maternal plasma were measured by Konelab 30 clinical analyser (Labmedics Ltd, Manchester, UK). Fetal pancreatic insulin content was measured by ELISA (Mercodia; Diagenics Ltd, Milton Keynes, UK). Data was analysed using a linear mixed model (restricted maximum likelihood) analysis.

Maternal live-weight gain was reduced in animals fed the low-protein diet. There was also an interaction with the oil type such that the protein effect was greater in maize oil diets compared with soya oil diets. In contrast, fetal growth was more sensitive to protein restriction in soya oil diets. Protein restriction also reduced maternal liver weight; however, this outcome was not affected by the oil type. The insulin content of the fetal pancreas did not differ between diets. Protein restriction increased maternal plasma TAG levels by approximately 2.5-fold. Soya oil also increased plasma TAG compared with maize oil. In contrast, plasma glucose levels did not differ between groups.

Table. Maternal and fetal characteristics at day 21 of gestation.

	18C (*n* 9)		9C (*n* 6)		18S (*n* 8)		9S (*n* 10)		*P*		
Diet ……	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Protein	Oil	Protein×oil
Dam live wt (g)	389[a]	6	366[b]	6	386[ab]	5	380[ab]	5	0.03	NS	0.05
Litter size (no. of fetuses)	14	0.7	14.3	1.3	15.9	0.9	14.9	0.7	NS	NS	NS
Mat liver wt (g)	13.3[a]	0.4	11.6[b]	0.5	13.2[a]	0.2	11.4[b]	0.2	<0.001	NS	NS
Mat plasma TAG (mM)	1.62[a]	0.23	3.91[b]	0.33	1.87[a]	0.15	5.06[c]	0.47	<0.001	0.07	NS
Mat plasma glucose (mM)	7.13	0.08	7.41	0.27	7.27	0.08	7.45	0.21	NS	NS	NS
Fetal body wt (g)	4.14[a]	0.11	4.03[a]	0.16	4.30[b]	0.11	3.93[a]	0.07	<0.001	NS	0.03
Female fetal pancreatic insulin content (μg)	4.18	0.33	4.77	0.24	4.42	0.33	4.12	0.20	NS	NS	NS

Values are means with their standard errors. Mat, maternal. a,b,c, Values with unlike superscript letters within rows were differ significantly ($P<0.05$).

Maize oil and soya oil differ in their *n*-3 PUFA:*n*-6PUFA. These results show that this ratio in the maternal diet modified the relative growth of maternal and fetal tissues. Protein restriction reduced fetal growth in soya oil-based diets, whereas maternal growth was affected in maize oil-based diets. Fetal pancreatic insulin contents were not affected by diet, suggesting that postnatal differences in insulin release may be the result of changes in signalling pathways. Protein restriction and oil type had no effect on plasma glucose, but did alter maternal lipid metabolism. The increase in plasma TAG in gestation may be associated with the programming of ACC and CPT-1 expression in the offspring.

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Maloney CA, Lilley C, Czopek A *et al.* (2007) *British Journal of Nutrition* **97**, 912–920.

Environmental influences on pre- and postnatal growth in sheep. By D.S. GARDNER[1] and M.E. SYMONDS[2], *Centre for Reproduction and Early Life, Schools of* [1]*Veterinary Medicine and Science, Sutton Bonington and* [2]*Human Development, University Hospital, University of Nottingham, Nottingham, UK*

Elsie Widdowson with Robert McCance (Widdowson, 1970; McCance & Widdowson, 1974; Widdowson & McCance, 1975) first illustrated the effects of dietary manipulation early in life on postnatal growth and body composition, the 'Harmony of growth'. These studies laid the mechanistic foundation for what was to become the developmental origins of adult disease hypothesis (Barker, 1994). This study robustly evaluates the many factors that influence prenatal and early postnatal growth in sheep, including maternal nutrition and the lactation environment.

Three independent datasets were used for analysis: (1) comprised 154 Mule and eighty-seven Welsh Mountain ewes, which were individually housed during gestation and thus individual nutritional intake (MJ/d) was known throughout gestation (392 cases of birth weight); (2) comprised 856 Mule ewes in which lamb birth weight (5821 cases) was known over an 11-year period for individual ewes; (3) comprised 3736 pedigree Suffolk ewes (13630 cases of birth weight) from 1982 to 2005 in which postnatal growth to 8 weeks and 20 weeks were known. In addition, computed tomography (CT; *n* 229, only at 8 weeks) and ultrasound scanning of fat and muscle depth at 20 weeks (range 128–146 d; lower and upper quartiles) of lean and fat issue at this age were known. For this group some triplets and all quads and quins were adopted to other ewes so that ewes suckled ideally two but no more than three lambs. Data are given as means with their standard errors and analysed using restricted maximum likelihood with ewe as a nested term on Genstat v8 (VSN International Ltd, UK).

Significant nutritional effects on weight at term in the lamb were ewe intake during late gestation (+207 (SE 3) g/MJ increase; $P<0.001$) and maternal body condition score (BCS) before gestation (high BCS (>3.5) to low BCS (≤2.0) reduced fetal weight:maternal weight from 8.4 (SE 0.4) to 6.1 (SE 0.5) % respectively; $P<0.05$). Within individual ewes over more than eight pregnancies a number of factors influenced lamb birth weight including (estimated effect size); parity (≤+351 (SE 36) g), gender (+351 (SE 36) g in males), litter size (twins, 692 (SE 40) g; triplets, 1.40 (SE 0.04) kg; quads, 2.08 (SE 0.11) kg), year of birth (≤+555 g) and being twice barren (–769 (SE 60) g). In the largest dataset these characteristics similarly influenced lamb birth weight, but also postnatal growth (g/d; estimated effect size): gender (+38 (SE 1) in males), litter size (relative to singles; twins, –38 (SE 19); triplets, –46 (SE 16); quads, –63 (SE 19); quins, –119 (SE 42)). Relative early growth (% increase) was inversely related to litter size ($P<0.001$), but weaning weight remained significantly less in triplets, quads and quins relative to singles and twins ($P<0.01$). CT fat and lean mass were strongly influenced by postnatal growth rate (r 0.58, $P<0.001$).

There are many influences on birth weight and postnatal growth rate in the sheep, of these litter size, lamb gender, parity and year of birth have the greatest influence. There is no evidence for maternal constraint of growth in multiparous ewes with singleton pregnancies. Lambs from large litters adopted by ewes with smaller litters show significant catch-up growth. The early growth of lambs has a direct effect on the deposition of lean and fat tissue at this time. A consideration of these factors is important in the design of studies examining the long-term adverse effects of the early environment in sheep; a contention proposed by McCance & Widdowson (1986) many years ago.

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Juvenile obesity rather than nutrient restriction *in utero* influences appetite regulation in the growing sheep. By S. SEBERT[1], H. BUDGE[1], D. KEISLER[2], M.E. SYMONDS[1] and D.S. GARDNER[1], [1]*Centre for Reproduction and Early Life, Queen's Medical Centre, University of Nottingham, Nottingham, UK and* [2]*Division of Animal Science, University of Missouri, Columbia, MO, USA*

Obesity and its cluster of metabolic disorders (insulin resistance, type 2 diabetes, CVD) are still rising dramatically worldwide. Various origins are now known to be involved in this unbalanced equilibrium between energy intake and energy expenditure. Obesity development could take place through centrally-mediated alterations of leptin signalling of appetite and energy expenditure. Moreover, recent prospective epidemiological studies corroborated by animal experiments have shown that adverse fat mass growth leading to obesity in adulthood could take place in early life.

In order to measure the effect of obesity and the potential additional influence of gestational energy restriction on appetite and energy expenditure, pregnant sheep were used. Sheep received either a control (C; 7 MJ/d; *n* 16) or nutrient restricted diet (NR; 50% C intake, approximately 3.5 MJ/d; *n* 13) from day 30 to day 80 and control diet thereafter (12–13 MJ/d up to term). They gave birth naturally and offspring were reared by their mother up to weaning. The offspring were then subjected to a low-activity increased-food-availability environment to promote fat deposition (obese controls (OC), *n* 8; obese nutrient-restricted (ONR), *n* 13) or pasture grazed with high activity and maintenance food availability (lean controls (LC), *n* 8). At 1 year of age blood samples were collected in order to measure plasma leptin concentrations. Weekly average and 24 h food intake and food intake over a 2 h period immediately post feeding were measured at this time. Animals were then humanely killed and entire hypothalami were snap-frozen for molecular biological analysis. Hypothalamic total RNA were extracted and treated with DNase and then RT. Resulting cDNA were used to measure gene expression of Agouti-related protein, melanocortin-3 and -4 receptor, neuropeptide Y, pro-opiomelanocortin and leptin receptor by real-time PCR. Gene expressions were standardised using 18S rRNA as a reference.

At 1 year old obese sheep (OC and ONR) were heavier than LC sheep, their mean body weights being 89.2 (SE 2.2), 87.3 (SE 1.5) and 57.7 (SE 3.2) kg respectively ($P<0.001$). Obesity in both obese groups was characterised by higher fasting plasma leptin concentrations than those of the LC group (Fig. 1). Average 24 h food intake did not differ between groups. They all consumed the same amount of daily energy (approximately 15 MJ/d). However, during the first 2 h of feeding the energy intake of the obese groups was half that of the LC group (Fig. 2), suggesting an alteration of feeding behaviour. Hypothalamic transcription of all genes studied was not influenced by obesity or gestational nutrient restriction.

Restrained physical activity alone induced obesity in sheep. The obesity outcome was characterised by high plasma leptin without modification of any of the hypothalamic genes involved in appetite or energy expenditure. However, independently of total energy intake, feeding behaviour was altered by obesity. Furthermore, despite high plasma leptin the expression levels of appetite controllers were not altered by obesity, suggesting the development of leptin resistance. Finally, no additional effects of nutrient restriction during mid gestation were observed.

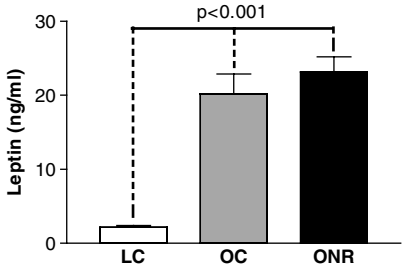

Fig. 1. Plasma leptin concentrations.

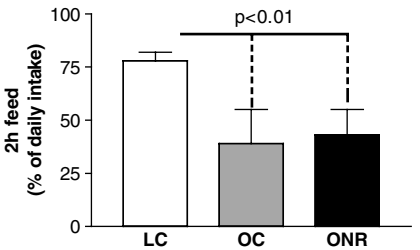

Fig. 2. The 2 h energy intake.

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From science to policy: experience of the Breastfeeding in Ireland Strategic Action Plan. By C.N.M. KELLY[1], V. BATT[2], M. FALLON[3] and S. NIC GABHAINN[1], [1]*Health Promotion Research Centre, 12 Distillery Road, National University of Ireland, Galway, Republic of Ireland,* [2]*Women's Studies Centre, National University of Ireland, Galway, Republic of Ireland and* [3]*National Breastfeeding Coordinator, Department of Health and Children, Republic of Ireland*

Healthcare decisions and policy-related issues are increasingly being made on research-based evidence. However, translating evidence into practice and policy can prove difficult and time consuming, not least because scientists are not always cognisant of the processes involved in policy-making (Lang, 2005). One area in which there is considerable evidence for benefits to health, society and the economy is breast-feeding. Yet, translating this evidence into practice and policy and in turn improving breast-feeding rates can prove difficult. Such was the case in the Republic of Ireland where, although the first national breast-feeding policy (Department of Health, 1994) led to numerous developments in breast-feeding protection, promotion and support within Ireland, the breast-feeding rate continued to be one of the lowest in Europe. The most up-to-date available breast-feeding rates at national level are 42.4% exclusive breast-feeding plus 3.2% partial breast-feeding at maternity hospital discharge in 2004 (National Perinatal Reporting System Unit, unpublished).

As a result, the Minister for Health and Children appointed the National Committee on Breastfeeding in 2002. The main focus of the Committee was to undertake a review of the 1994 National Breastfeeding Policy, and at the time Ireland was the only European country to undertake this task (EU Project on Promotion of Breastfeeding in Europe, 2003). This review paved the way for a 5-year strategic action plan for breast-feeding in Ireland. Members of the Committee included those in key positions in statutory and voluntary services related to expectant parents and breast-feeding families as well as representatives of women's organisations and the general public.

The scientific evidence and the members' views, along with the public submissions, were the main sources of information employed in undertaking the review of the 1994 National Breastfeeding Policy, which was published in 2003 (Department of Health and Children, 2003). The commitment to the promotion of breast-feeding from everyone involved was unquestionable. However, there was considerable debate on the prominence of certain issues, e.g. rooming-in and the role of mid-wives in breast-feeding initiation. The role of the scientists involved was to consider the scientific evidence as well as practical issues relevant to the Irish context, but equally the expectations of the policy makers, who themselves have agendas and criteria to be considered. Disseminating the findings in a policy-relevant format was essential to the success of the strategic action plan. It is recognised that the policy–evidence relationship can be complex and policy-making can be political, and that lobbying from interest groups can sometimes benefit, but also thwart, evidence-based policy (Lang, 2005). Yet, the publication of the strategic action plan for breast-feeding in Ireland (DOHC, 2005) demonstrates that international research and current best practice can successfully find its way into policy.

The experience in Ireland highlights the need for future reviews of nutritional science to be targetted specifically to policy issues and thus policy makers, and for these reviews to be published in peer-reviewed journals. There are numerous published articles which refer, albeit briefly, to the implications of findings on practice or policy. Journal editors and reviewers should insist that further details of how this might happen be included in articles to be published or consider the inclusion of specific policy reviews in mainstream journals.

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Nutrition programming statements in materials on infant feeding aimed at parents: comparison among five European countries. By J. VON ROSEN-VON HOEWEL[1], K. LAITINEN[2], M.A. SCHMID[3], T. DECSI[4], E. MARTIN-BAUTISTA[5], B. KOLETZKO[1], V. JAKOBIK[4], C. CAMPOY[5], H. GAGE[3], J. MORGAN[3] and M.M. RAATS[3], [1]*Dr von Hauner Children's Hospital, Ludwig-Maximilians-University, Munich, Germany,* [2]*Department of Biochemistry and Food Chemistry, University of Turku, Turku, Finland,* [3]*Food, Consumer Behaviour and Health Research Centre, University of Surrey, Guildford GU2 7XH, UK,* [4]*Department of Paediatrics, University of Pécs, Pécs, Hungary and* [5]*Department of Paediatrics, University of Granada, Granada, Spain*

Although the association between early nutrition and later health outcomes known as metabolic programming is well acknowledged amongst researchers, the extent to which this concept is being communicated to parents is not known. The frequency and content of programming statements found in written materials aimed at parents and produced by national governmental bodies, professional and consumer associations, special interest groups and industry were reviewed in five European countries.

Stand-alone leaflets, pamphlets and booklets (termed leaflets) targetted towards parents and published from 2000 to 2005 and all issues from 2005 of the most popular monthly parenting magazine providing information on the feeding of healthy infants aged 0–12 months were sourced in each country. Materials targetting older children, mothers or health professionals and focusing on legal and practical aspects or specific diseases were excluded. Altogether 130 documents (England thirty-six, Finland eight, Germany fourteen, Hungary thirty-eight, Spain thirty-four) and 161 articles and notes from sixty magazine issues were screened for nutrition programming statements on nutrients, food items and feeding behaviour in relation to short-term (<5 years), medium-term (5–15 years) and long-term (>15 years) health outcomes of the infant. Statements on non-nutritive substances, non-feeding-related behaviour, vitamin and mineral supplementation and nutrient deficiencies were excluded.

In total 638 programming statements were identified. It was found that 76.0% (*n* 100) of the leaflets and 41.4% (*n* 66) of the magazine articles and notes contained programming statements. The percentage of statements in all materials was highest in Spain (88.6), followed by Hungary (67.3), Germany (50.8), Finland (45.8) and England (42.2) ($P<0.001$). The most frequently documented health outcomes are listed in the Table. The dominating category for England, Germany and Hungary was allergy, whereas it was risk of infections for Spain and growth and development for Finland. The majority of statements (68.2%, *n* 435) did not refer to the duration of the programming effects; of the remaining statements 18.2% (*n* 122) referred to short-term, 5.1% (*n* 33) to medium-term and 7.5% (*n* 48) to long-term programming effects. The most frequently mentioned health outcomes for short-term programming were risk of infections (30.3%), allergy (16.4%) and risk of diseases in general (14.8%), and for long-term programming those mentioned were obesity (22.9%), the risk of CVD (14.6%) and health in general (14.6%).

Most frequently mentioned health-outcome categories	England		Finland		Germany		Hungary		Spain		All countries	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Allergy	46	25.7	4	10.5	44	22.2	28	23.5	10	9.6	132	20.7
Risk of infection	41	22.9	3	7.9	13	6.6	20	16.8	22	21.2	99	15.5
Growth and development	10	5.6	7	18.4	34	17.2	9	7.6	13	12.5	73	11.4
Risk of disease in general	19	10.6	3	7.9	10	5.1	9	7.6	10	9.6	51	8.0
Obesity	10	5.6	4	10.5	9	4.5	9	7.6	11	10.6	43	6.7
Mental development	9	5.0	1	2.6	12	6.1	9	7.6	8	7.7	39	6.1
Other health outcomes	44	24.6	16	42.1	76	38.3	35	29.4	30	28.8	201	31.0

In summary, the concept of programming effects of early nutrition on later health has been integrated to a considerable extent into infant nutrition information aimed at parents in these five European countries. However, substantial variation in the frequency of statements in materials and the emphasis of the type of health outcome was found amongst the countries. Furthermore, neither the long-term perspective of nutrition programming nor the intrinsic life-course definition of programming was evidently represented or reflected in the statements.

Promoting recommended infant feeding practices in a low-income-sample randomised control trial of a peer-support intervention. By R.G. WATT[1], E. DOWLER[2], R. HARDY[1], Y. KELLY[1], P. McGLONE[3], B. MOLLOY[4], K.I. TULL[1] and M. WIGGINS[5], [1]*Department of Epidemiology and Public Health, University College London, 1–19 Torrington Place, London WC1E 6BT, UK,* [2]*Department of Sociology, University of Warwick, Coventry CV4 7AL, UK,* [3]*Primary Care Research Network, Peninsula Medical School, Knowledge Spa, Royal Cornwall Hospital, Treliske, Truro TR1 3HD, UK,* [4]*Community Mothers Programme, 1st floor, Park House, North Circular Road, Dublin 7, Eire, and* [5]*Social Science Research Unit, Institute of Education, 18 Woburn Square, London WC1H 0NR, UK*

The objective of this project was to assess the effectiveness of a peer-support intervention on infant feeding practices in Camden and Islington, London, UK over a 15-month period from December 2002 to February 2004.

A randomised controlled trial compared nutritional and other outcomes for women offered volunteer support with those for control women who only received standard professional care. The sample was recruited using advertisements in free local papers and council run hostels, but mainly at baby clinics. The 312 women were allocated at random to the intervention (157) or control group (155). Data was collected at baseline when the infants were 10 weeks old, post intervention when the children were 12 months old, and at 6 months follow up when the children were 18 months old. Nutrient intakes, fruit and vegetable consumption, feeding practices, growth and use of health services were also assessed for each child. Mothers were interviewed at each stage of the study, and information was gathered on mother's health, fruit and vegetable consumption, nutritional knowledge and confidence. In addition, a detailed process evaluation was conducted. A group of local volunteers were recruited and trained to provide non-judgemental support and practical assistance on infant feeding, in particular weaning practices. Home-based support was offered over a 9-month period until the infants were 12 months old.

Nutrient data from 24-hour multiple pass recalls at each stage was entered and analysed using the CompEat™ nutrient database. The macro- and micro-nutrient intakes at each stage were similar in each group (data not shown). Both the macro- and micro-nutrient intakes were in line with the recommended (RNI) and lower recommended nutrient intake (LRNI) values. Consumption of fresh fruit and vegetables was gathered through the use of a food frequency questionnaire at the 12 and 18 month visits. The effect of the intervention on the test group at each project stage is shown below:

Significant differences at 12-month stage ($P<0.05$)	Significant differences at 18-month stage ($P<0.05$)
More carrots, boiled potatoes, apples and pears consumed	Consumed more boiled potatoes, chips and pears
Less likely to be given goat's milk or soya milk	Mothers more knowledgeable about when bottle feeding should be discouraged
More likely to be eating family foods and having three solid meals per day	Mothers were more confident in following health professionals' recommendations on how best to feed their child

Although both the women and the volunteers valued the intervention, there was no evidence of any benefit in macro- and micro-nutrient intakes at either the post intervention or follow-up stage. Nevertheless, the intervention did achieve benefits on infant feeding practices and improved nutritional knowledge and confidence. A detailed process evaluation demonstrated a range of positive impacts for both the mothers and volunteers involved in the intervention.

We would like to acknowledge the Food Standards Agency, as well as the mothers, children and volunteer peer supporters, for their help with this intervention.

The evaluation of an FFQ to determine energy, macronutrient, calcium, iron and zinc intakes of infants aged 6 months. By L.D. MARRIOTT, S.M. ROBINSON, J. POOLE, S.E. BORLAND, W.T. LAWRENCE, H.M. INSKIP, C. COOPER & THE SOUTHAMPTON WOMEN'S SURVEY (SWS) STUDY GROUP, *MRC Epidemiology Resource Centre, University of Southampton, Southampton General Hospital, Southampton SO16 6YD, UK*

To understand the role of diet in infant growth and development, it is important to be able to determine energy and nutrient intakes with accuracy. We have developed an FFQ to assess the diets of infants aged 6 months, for use in a large general population survey, the SWS (Inskip *et al*. 2006).

The infants of women in the SWS are visited within 2 weeks of the infant's 6-month birthday; infant diet is assessed using an administered FFQ. This assessment determines the average frequency of consumption and the amount consumed for milks and thirty-four food items during the week preceding the interview. The information for any additional foods consumed once or more weekly is similarly noted. Between 2001 and 2003 a sub-sample of fifty families completed a 4-d weighed-intake diary (WD) within 2 weeks following completion of the FFQ. Each WD recorded all milks, foods and drinks consumed by the infant. The majority of WD (84%) were completed on four consecutive days. Breast-milk intake, in both the FFQ and the WD, was estimated using an algorithm (Mills A & Tyler H 1992; Paul *et al*. 1988). Nutritional composition information for baby formulas and foods was obtained from manufacturers and/or by calculation from recipe ingredients. To evaluate the relative validity of the FFQ, the results from the FFQ have been compared with those from the WD.

We report the median intakes and inter-quartile ranges (IQR) for energy, macronutrients, Ca, Fe and Zn for the sub-sample of infants assessed by FFQ and by WD. Bland-Altman plots were used to compare absolute intakes of energy and nutrients between the FFQ and the WD. The mean differences (%) between the two methods and the limits of agreement (95% CI) are shown in the table.

There were an equal number of boys and girls in the sub-sample and 28% were still receiving breast milk at WD collection.

	FFQ (*n* 50)		WD (*n* 50)		Spearman rank correlation*	Mean difference (%)	Limits of agreement(%)
	Median	IQR	Median	IQR			
Energy: kJ	3329	2804–3792	2968	2728–3423	0.41	6.2	−40 to 52
kJ/kg body wt	424	366–486	370	342–423	0.43	8.9#	−37 to 55
Protein (g)	20.6	17.9–24.3	19.7	17.4–23.6	0.51	0.6	−48 to 49
Fat (g)	31.3	28.4–37.3	31.3	27.6–34.7	0.39	3.6	−47 to 54
Carbohydrate (g)	106	86.5–118.5	93.1	81.1–106.9	0.51	9.2#	−37 to 55
Ca (mg)	546	462–668	543	419–726	0.62	3.4	−58 to 65
Fe (mg)	7.0	4.9–9.1	6.9	4.9–8.7	0.75	2.0	−59 to 63
Zn (mg)	5.2	4.2–5.9	4.7	3.8–5.5	0.69	7.4#	−44 to 59

P* for rank <0.01; P for mean differences <0.05 where indicated with#.

Although there were some differences in absolute energy and nutrient intakes assessed by the FFQ and WD, the Spearman rank correlation coefficients indicate reasonable agreement in the ranking of infants' intakes. Thus, the FFQ is an appropriate tool for use in population studies and yields useful information about the diets of infants aged 6 months.

This work was supported by the Medical Research Council, University of Southampton and British Heart Foundation.

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Attitudes and perceived knowledge about food allergy in parents of young children in five European countries. By K. SYNOTT[1] J. BOGUE[1], J. SCOTT[2], S. AMARRI[3], F. BENATTI[3], A. GIL[4], A. UUSIJÄRVI[5], E. NORRIN[5], C.A. EDWARDS[2] & other members of INFABIO project, [1]*Department of Food Business and Development, University College Cork, Western Road, Cork, Republic of Ireland,* [2]*Human Nutrition Section, University Division of Developmental Medicine, Yorkhill Hospital, Glasgow G3 8S, UK,* [3]*Department of Paediatrics, University of Modena and Reggio Emilia (UMRE), Via del Pozzo, 71, 41100 Modena, Italy,* [4]*Department of Biochemistry and Molecular Biology, Faculty of Pharmacy, Department of Microbiology, Laboratory of Microbial Taxonomy and Department of Paediatrics, University of Granada, Campus de Cartuja, 18071 Granada, Spain, and* [5]*Microbiology and Tumor Biology Centre (MTC), von Eulers vag 5, Karolinska Institutet, 171 77 Stockholm, Sweden*

The prevalence of food allergy is increasing in Europe and is a cause of great concern. The type of allergy appears different across countries but little is known about what concerns parents of young children have about food allergy. Identification of parental knowledge of and attitudes to foods and feeding practices associated with food allergy in infants is important to inform advice that may be given. The objectives of the present study therefore, were to analyse parents' attitudes to foods associated with infant allergy and to explore their views on infant diet, health and allergies. A total of 616 parents of infants <12 months of age were recruited in postnatal wards and asked to complete the pre-tested questionnaire before the introduction of solid food to the infant's diet. All parents were locally recruited using convenience sampling in five countries: Germany (*n* 96), Italy (*n* 129), Scotland (*n* 174), Spain (*n* 85), Sweden (*n* 132). Descriptive statistics were used to generate the percentage of participants from each country, who agreed and disagreed with a variety of statements related to the causes of food allergy. Further χ^2 tests were used to illustrate significant differences in attitudes relating to allergy statements across the countries studied ($P<0.05$).

Primary prevention strategies aimed at preventing or delaying food allergies in children with a family history of allergy include exclusive breastfeeding to 6 months of age, introduction of solid foods after 6 months and introduction of cow's milk after 12 months. (Fiocchi *et al*. 2006). The majority of all parents (76.2%) agreed that breastfeeding prevented allergies. However, only 26% of all parents agreed that introducing solids at an early age and 40% that cow's milk consumption before 12 months contributed to the development of allergies. Only in Germany did the majority of parents (69%) agree that cow's milk consumption before 12 months contributed to allergies in infants, whereas 60% of Italian parents disagreed with this statement. Cow's milk, gluten, eggs and seafood-shellfish were the food most commonly associated with infant allergy. Strawberries were the most common fruit associated with allergy, while meat and vegetable products were seldom linked with allergy. There were some notable between country differences in other individual foods identified as causing allergies. For instance, peanuts were associated more with allergy in Scotland (90%) and Sweden (85%), than in Italy (24%). Spanish parents only identified peaches (49%) and bananas (33%) as allergy-causing foods whereas wheat was associated with allergy by Scottish participants (62%). Other individual food products highlighted were tomatoes in Sweden (62%) and citrus fruits in Germany (66%).

In conclusion, there are important differences between European countries in attitudes towards infant feeding practices and foods associated with allergy. These findings highlight the importance of exploring these cultural differences to inform the provision of information relative to cultural needs.

This work was funded by the EU Commission (Project QRLT 2002 02606; INFABIO; Effect of diet and lifestyle on risk of gastrointestinal infection and allergy in early life; consumer knowledge, attitudes and needs).

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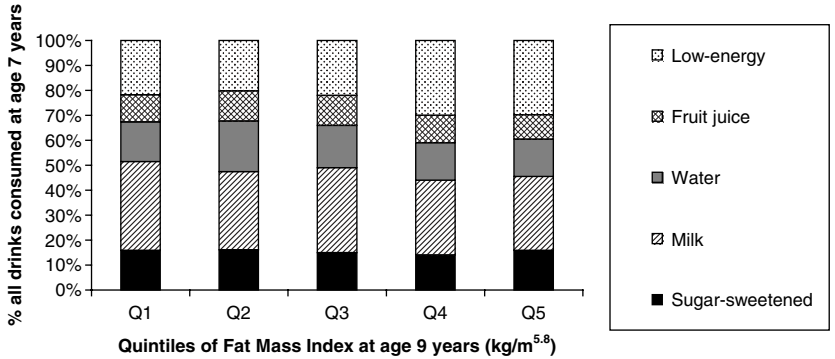
Is sugar-sweetened beverage consumption associated with increased fatness in children? By L. JOHNSON[1], A. MANDER[1], L.R. JONES[2], P.M. EMMETT[2] and S.A. JEBB[1], [1]*MRC Human Nutrition Research, Cambridge, CB1 9NL and* [2]*ALSPAC, University of Bristol, BS8 1TQ*

The World Health Organization (World Health Organization/Food and Agriculture Organization, 2003) has implicated the excessive consumption of sugar-sweetened beverages (SSB) as a 'probable contributor' to the obesity epidemic. Experimental studies support plausible mechanisms through which SSB may increase energy intake and promote long-term weight gain through a reduced satiety response and poor compensation for liquid energy. Large prospective studies have reported inconsistent evidence for a positive association between SSB intake and body weight (Malik *et al.* 2006).

The impact of SSB consumption at age 7 years on fatness at age 9 years was assessed in a random subsample of children from a prospective cohort study in Avon, England (*n* 682). Diet data were collected using 3 d diet diaries and beverages were categorised into: sugar-sweetened; low energy; fruit juice; milk and water. Consumption was defined as volume (g/day) and % all drinks volume. Fat mass was measured using dual-energy X-ray absorptiometry. Fat Mass Index (FMI) was calculated by dividing fat mass (kg) by height$^{5.8}$ (m) in order to adjust for body size (Wells & Cole, 2002). Overweight (*n* 137) was defined as the top quintile of FMI, which equates to the 20% of children in this sample identified as overweight using International Obesity Task Force BMI cut-offs (Cole *et al.* 2000).

In the whole sample, children consumed 129 g/day of SSB, which accounted for 15.5% all drinks consumed daily. SSB consumption was not associated with logFMI (σ −0.03 p=0.482) or overweight status. In contrast low-energy drinks were correlated with logFMI (σ 0.147 p=0.0001) and accounted for 30% of total drinks in overweight children compared with 24% in the remaining sample. This was equivalent to 212 g/day and 273 g/day in normal and overweight children respectively. In a multivariate logistic regression this association was explained by BMI at 7 years (OR 1.01 (1.00 to 1.02) vs. OR 1.00 (0.992–1.01)).



Our analysis shows no evidence for an association between SSB consumption at age 7 years and fatness at age 9 years in this cohort of UK children. In this prospective analysis the relationship with low-energy beverages suggests that heavier children may consume low-energy beverages as part of a weight-control programme.

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Ethnicity-related variation in upper body fatness in East London schoolchildren. By D. SAMANI[1], L. PROSSER[2], C. ALSTON[2] and H.D. McCARTHY[1], [1]*Institute for Health Research & Policy, London Metropolitan University, Holloway Rd, London N7 8DB, UK and* [2]*The Learning Trust, 1 Reading Lane, London E8 1GQ, UK*

An excess accumulation of adipose tissue content in the upper body or abdominal region is associated with raised CVD risk, including an atherogenic lipoprotein profile and raised fasting insulin levels (Esmaillzadeh *et al.* 2006). This is the case in children as well as in adults. Furthermore, children from South Asian, African and Caribbean backgrounds are at greater risk for obesity-related ill health compared with Caucasians (Morrison *et al.* 1999; Whincup *et al.* 2002). The cause of this increased risk is not entirely clear, although it may be related to early growth and body fatness in childhood (Khunti & Samani, 2004). The present cross-sectional study compared upper body fatness in children from different ethnic backgrounds.

A total of 2667 children from East London aged between 4 and 13 years participated in the study. Children were divided into six ethnic groups: Caucasian; South Asian; African; Caribbean; mixed background; other ethnic group. Height, weight and waist circumference (WC) were measured. For the present study WC standard deviation score (SDS) was calculated and compared against the current UK WC reference data (McCarthy *et al.* 2001). Mean WC SDS was calculated separately in boys (M) and girls (F) and for each ethnic group. The percentage of children exceeding the 91st (overweight) and 98th (obese) centiles for WC was calculated. Finally, waist:height ratio (WHtR) was calculated and the percentage of children exceeding the 0.50 boundary value was determined (McCarthy & Ashwell, 2006).

A wide variation in WC indices was observed between ethnic groups and gender.

	Total no.		Mean WC SDS		%>WC 91st centile		%>WC 98th centile		Mean WHtR		% with WHtR >0.50	
Ethnic group	M	F	M	F	M	F	M	F	M	F	M	F
Caucasian	437	394	0.68	0.81	27.2	25.8	14.4	13.5	0.45	0.45	17.6	17.0
Mixed	125	113	0.51	0.32	24.0	20.4	9.6	8.8	0.45	0.44	12.7	8.7
South Asian	224	215	0.02	0.12	17.9	19.5	8.5	8.4	0.44	0.44	10.0	11.2
Caribbean	199	176	0.57	0.81	23.6	33.0	12.1	18.8	0.44	0.45	12.1	16.5
African	286	291	0.65	0.98	29.7	36.8	12.9	21.6	0.45	0.45	11.5	17.9
Other	102	105	0.58	0.52	28.4	28.6	11.8	9.5	0.45	0.45	13.7	15.2

These findings indicate that upper body fatness is highest in Caribbean and African girls when based on WC centile. However, when height is taken into account, this difference from other ethnic groups is not observed. Whilst it appears that South Asian children have the lowest prevalence of upper body obesity in this cohort, this difference is also reduced when height is taken into account. In conclusion, caution should be exercised when interpreting WC measures in children from different ethnic groups if height is not taken into account.

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Infant body composition and later health outcomes: prospective follow-up study. By S. CHOMTHO, J.C.K. WELLS, J.E. WILLIAMS and M.S. FEWTRELL, *MRC Childhood Nutrition Research Centre, Institute of Child Health, WC1N 1EH, UK*

There is increasing evidence from longitudinal studies that a pattern of rapid weight gain during early infancy is associated with obesity (defined by BMI) (Stettler *et al.*, 2003; Ong *et al.*, 2000). Longitudinal studies of the effects of alterations in infant BC on later obesity and cardiovascular health outcomes would be valuable to examine whether specific components of growth (e.g. fat mass (FM) or fat-free mass (FFM)) are important for long-term health outcomes, which might in turn provide clues about mechanism.

Fifty-nine (twenty-three boys) healthy full-term UK adolescents who had had BC measured using doubly-labelled water at the age of 12 weeks and skinfold thickness (SF) measured during infancy as a part of an infant nutrition study were followed up at the age of 14.4 (SD 2.6) years. Primary outcomes were total FM and FFM, assessed by the four-component model (4C), and regional FM, assessed by dual-energy X-ray absorptiometry. FM index (FMI, FM/height^2) and FFM index (FFMI, FFM/height^2) SD scores (SDS) were calculated using the authors' reference data by the LMS method. Secondary outcomes were blood pressure, cholesterol, HDL-cholesterol, glucose, insulin, proinsulin and split-proinsulin.

At follow up mean BMI SDS was –0.09 (SD 1.12) in boys and 0.50 (SD 1.09) in girls. Twelve (20.3%) adolescents were overweight and one (1.7%) was obese. There was no significant association between infant BC at 12 weeks and adolescent BC. Sum of triceps and subscapular SF (sum SF) at the age of 3 weeks was positively associated with adolescent FFMI SDS. Sum SF at 6 weeks was positively related to FMI SDS, WC SDS, and trunk FMI SDS. Sum SF at 6 weeks (*n* 33) was positively correlated with later proinsulin (*r* 0.41, *P* 0.02), 32–33 split proinsulin (*r* 0.40, *P* 0.02), and showed a weak positive correlation (*r* 0.32, *P* 0.08) with HOMA IR (Matthews *et al.*, 1985). These associations persisted after adjusting for gender, length, birth weight SDS, infant diet, pubertal status, physical activity, social class or parental BMI. There were no associations between sum SF at the age of 12 weeks, 6 months or 12 months and later BC or cardiovascular risk factors.

Regression of current BC *v.* sum SF during different periods in infancy*

	Sum of triceps and subscapular SF at														
	3 weeks (*n* 31)			6 weeks (*n* 42)			12 weeks (*n* 58)			6 months (*n* 39)			12 months (*n* 32)		
Later BC	B	SE	*P*	B	SE	*P*	B	SE	*P*	B	SE	*P*	B	SE	*P*
BMI SDS	2.40	1.20	0.06	2.67	1.02	0.01	0.93	0.94	0.33	1.69	1.20	0.17	0.03	0.89	0.97
FMI SDS	1.12	0.96	0.26	1.58	0.80	0.06	0.64	0.72	0.38	1.06	0.92	0.26	−0.19	0.68	0.78
FFMI SDS	2.45	1.05	0.03	1.47	0.96	0.14	0.40	0.84	0.63	1.42	1.08	0.20	−0.01	0.79	0.99
WC SDS	1.76	1.10	0.12	3.49	0.97	0.001	0.96	0.90	0.30	1.08	1.28	0.41	0.11	0.83	0.89
Trunk FMI SDS	1.72	1.08	0.13	1.94	0.90	0.04	0.74	0.83	0.37	1.39	1.04	0.19	−0.09	0.78	0.91

*From multiple regression analysis; each row represents a different model with later BC as a dependent variable; sum SF was an independent variable; exact age at each time point and gender were covariates; B=the coefficient of sum SF ($\log_e$ scale) i.e. the change in later BC per 100% increase in sum SF (Cole, 2000).

From this small study, there is some evidence to suggest that infant 'fatness' as measured by SF at 3 weeks is positively related to later FFM, whereas higher SF at 6 weeks may relate to later FM and central fat distribution; these findings suggest that the period before 12 weeks might be important for programming of BC and later health outcomes, but this hypothesis requires testing in a larger study.

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Evaluation of health campaigns in schools; Food Awareness Week, East Berkshire. By S. RABEE[1], P. COLLINGS[2], J. COPP[2] and O.B. KENNEDY[1], [1]*Hugh Sinclair Human Nutrition Unit, Department of Food Biosciences, University of Reading, PO BOX 226, Reading, RG6 6AP and* [2]*George Ward, St. Mark's Hospital, Maidenhead, Berkshire, SL6 6DU*

The prevalence of obesity in children over the last 10 years has risen from a rate of 2.0 fold to 2.8 fold (Chinn, 2001). Targeting children at primary and secondary school level with nutrition education has been reported to affect early health related beliefs and attitudes which consolidate to dictate future behaviour (Hackett, 2002). The purpose of this study was to evaluate the Food Awareness Week in East Berkshire. Food Awareness Week is a week-long nutrition education intervention scheme run by the East Berkshire Health Promotion team and comprises of a variety of activities, based around teaching 3 key messages of 5-a-day, the Balance of Good Health (BoGH) and 1-hour of physical activity. Every year a target school is selected to receive special attention from the dietitian and health promotion team (FAWD). The aim of the study was to investigate the effectiveness of these 3 key messages with another school participating in Food Awareness Week run by the school alone (FAW) and to a school not participating in Food Awareness Week (NFAW).

Prior to FAW the children completed a questionnaire which assessed their knowledge of the 3 key areas mentioned above. This process was repeated after intervention with the same questionnaire. A total of 792 participants returned their questionnaires pre, and 518 post intervention. The overall response rate was 36%.

FAWD saw a significant increase from baseline ($P<0.001$) in self-reported consumption of fruit and vegetables, compared to FAW. The same was also reported for the recognition of the Balance of Good Health diagram.

With respect to current self-reported physical activity, FAWD saw a significant increase from baseline ($P<0.001$) in participation, whereas NFAW was not significantly different, FAW on the other hand significantly decreased ($P<0.001$).

		Measure			
		FI (portions/day)	VI (portions/day)	PA (hours/day)	BoGH (%recognise)
Group	Evaluation	Mean±SD			
FAWD	Pre	2.87±1.82	2.28±1.56	2.27±2.12	68.64
	Post	3.67±1.71	3.11±1.95	3.20±2.48	80.46
FAW	Pre	3.29±2.27	3.03±2.12	4.24±3.07	70.78
	Post	3.28±1.70	3.00±2.00	2.85±2.00	85.39
NFAW		3.13±1.76	3.16±2.39	3.25±2.64	73.68

SD=standard deviation, FAWD=intervention with dietitian & health promotion team, FAW=intervention without dietitian & without health promotion, NFAW=no intervention, FI=Fruit intake, VI=Vegetable intake, PA=Physical activity.

The results suggest that the involvement of the dietitian and health promotions team made a significant increase in awareness of the 3 messages over the week. Schools running the scheme alone did not increase awareness of the food and healthy lifestyle messages when compared to a non-participating school. These results show that the scheme has negligible effect (or even a negative effect) on children unless there are dietitians and other health promotion teams present to supervise the activities.

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Low vitamin D status and poor eating habits among Kuwaiti adolescent females: a public health concern for optimisation of bone health. By K. ALYAHYA[1,2], Z. ALMAZEEDI[2], J.B. MORGAN[1], J. BERRY[3], S.A. LANHAM-NEW[1] and W.T.K. LEE[1], [1]*Centre for Nutrition & Food Safety, School of Biomedical and Molecular Sciences, University of Surrey, GU2 7XH,* [2]*Department of Pediatrics, Al-Sabah Hospital, Kuwait,* [3]*Vitamin D Research Group, Department of Medicine, University of Manchester, Manchester, M13 9WL*

Despite the critical time of the adolescent years to bone health and development, the eating habits of adolescent females is a cause for concern for bone health optimization. Rare consumption of milk and dairy products, while regular consumption of carbonated beverages has been widely reported in Caucasian subjects (Harkness & Bonny, 2005). Low vitamin D (ie. low 25OHD) levels among adolescent females have been confirmed in the Middle East (Gannage-Yared *et al*. 2000) and else where (Moore *et al*. 2004). Thus, the aim of this study was to assess the vitamin D status and eating habits of the Kuwaiti adolescent females and to examine their likely impact on peak bone mass attainment.

A total of 82 adolescent females were enrolled (mean age 14.5 y ± 1.76 SD). Anthropometric and pubertal assessment (months since menarche, MSM) were performed. A standard food frequency questionnaire was completed. Fasting blood samples were collected for the assessment of vitamin D status, PTH, & calcium. Lumbar spinal BMC and BMD (L1–L4) were measured using DXA.

Results showed that none of the girls were sufficient in vitamin D (ie., 25OHD <30 ng/ml), and 80% of them had levels below 12 ng/ml. Daily consumption of milk, and cheese & cream was found among 16% and 35% of the females respectively. In addition, 23% did not consume milk at all, and 35% had a daily consumption of carbonated beverages. The table shows the biochemical, BMC and z-score values.

Vitamin D and bone indices of the Kuwaiti adolescent females (n=82).

Variable	Mean	±	SD
25(OH)D (ng/ml)	8.45	±	4.5
$1,25(OH)_2D$ (pg/ml)	41.66	±	20
PTH (pg/ml)	84.8	±	87
Corrected calcium (mmol/L)	2.24	±	0.1
LSBMC (g)	46.63	±	9.1
LSBMCZ-score	−0.08	±	1.1

In light of the literature, these results suggest that the low vitamin D status and the poor eating habits of the Kuwaiti adolescent females, aged 10–18 years, may not promote a healthy bone state. However, further analysis is underway to examine the full effect of these and other factors on bone mineral density.

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