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PROCEEDINGS OF THE NUTRITION SOCIETY

ABSTRACTS OF COMMUNICATIONS

The Three Hundred and Seventeenth Meeting of the Nutrition Society was held at the Royal Society of Medicine, Wimpole Street, London W1 on Friday 19 *May* 1978, *when the following papers were read:*

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The relationship between body build in infancy and percentage body fat in adolescence: a 14 year follow-up on 102 infants. By J. V. G. A. DURNIN and F. M. MCKILLOP, *Institute of Physiology, University of Glasgow, Glasgow G12 8QQ*

There is controversy regarding the hypothesis that infant feeding practices, particularly those involving high energy intakes, stimulate fat cell replication which may lead to obesity in later life. Recent studies by Poskitt & Cole (1977) and Whitelaw (1977) show that weight in infancy does not necessarily indicate subsequent body build.

During 1962–64, the heights, weights and food intakes were measured on 400 infants aged from birth to 2 years living in Glasgow and an adjacent region.

A follow-up study has been done on as many of these infants as possible to see if there was a relationship between body build in infancy and the development of obesity in adolescence.

Of the original 400 infants, only 102 could be traced, largely due to the extensive rehousing which has occurred in the Glasgow area during the intervening period.

The infants were classified by two methods using the reference standards of Tanner.

(1) Shukla Index: $\left(\frac{\text{actual weight}}{\text{actual height}}\right) \times \left(\frac{\text{50th centile height for age}}{\text{50th centile weight for age}}\right) \times 100\%$

This index tends to classify tall children as overweight and short children as underweight.

(2) Eid Index: $\left(\frac{\text{actual weight}}{\text{50th centile weight for age when height is on 50th centile}}\right) \times 100\%$

Using both indices, infants were classified as follows: Underweight, $<90\%$; Normal, 90–110%; Overweight, 110–120%; Obese, $<120\%$.

In the adolescents, the percentage body fat was calculated from the skinfold thicknesses at the biceps, triceps, subscapular and suprailiac regions (Durnin & Rahaman, 1967).

A high percentage body fat ($\geqslant 30\%$) in the adolescent girls was positively correlated with overweight and obesity in infancy (r 0·88 using Eid Index) but the converse was not necessarily true (r −0·20 using Eid Index), i.e. fat female infants did not necessarily become fat adolescents but fat adolescents tended to have been fat in infancy.

In the boys, only very low correlations were found either between their relative weight in infancy and their fatness in adolescence (r=0·14) or between those who were fat in adolescence (fat $\geqslant 18\%$) and their relative weight in infancy (r=0·17).

Durnin, J. V. G. A. & Rahaman, M. M. (1967). *Br. J. Nutr.* 21, 681.
Poskitt, E. M. E. & Cole, J. J. (1977). *Br. Med. J.* 1, 7.
Whitelaw, A. (1977). *Lancet*, November 26.

Haematological consequences of feeding trout with a single cell protein (*Hansenula anomala*). By F. J. SANCHEZ MUNIZ, M. DE LA HIGUERA, F. J. MATAIX and G. VARELA, *Facultades de Farmacia y Veterinaria, Universidad Complutense de Madrid, Madrid–3, Spain*

This study was done in order to investigate some haematological factors when trout were fed on *Hansenula anomala* grown on synthetic ethanol as the only protein source. These results try to complete our previous findings on some nutritive aspects (Sanchez *et al.* 1977).

Plasma urea showed a clear tendency to increase on yeast diet, and plasma ammonium significantly did. On the other hand although plasma uric acid was not modified, it showed higher values in yeast-fed animal kidney. The results suggest an increased protein and nucleic acid metabolism, probably a consequence of yeast chemical composition. Total serum protein levels (TSP) were not affected by yeast intake, but the percentages of albumin and β-globulin fractions, as well as the ratio albumin:globulin, were modified. The values obtained for both haemoglobin and haematocrit were similar in the two groups and were in the range given by Blaxhall & Daisley (1973). Red blood cell count (RBCC) for trout fed on yeast diet increased (about 43%) very significantly. These three haematological values permitted us to calculate the mean corpuscle volume (MCV), mean corpuscle haemoglobin (MCH) and mean corpuscle haemoglobin concentration (MCHC). These parameters decreased in the experimental group as a result of an activated erythropoiesis.

	Control diet (50% fish protein)	Yeast diet (50% yeast protein)	Student's *t* test
Food intake (g dry matter)	40·8 ± 5·8	26·4 ± 2·6	$P<0.05$
Plasma uric acid (mg/100 ml)	1·5 ± 0·6	1·3 ± 0·1	NS
Kidney uric acid (μmol/g)	134·0 ±17	403·0 ±84	$P<0.01$
Plasma urea (mg/100 ml)	41·4 ± 3·6	77·6 ±16·0	NS
Plasma ammonium (mg/100 ml)	3·4 ± 0·3	5·2 ± 0·4	$P<0.05$
Albumin (g/100 g TSP)	34·6 ± 1·6	43·3 ± 1·6	$P<0.02$
β-globulin (g/100 g TSP)	32·1 ± 1·2	22·6 ± 0·9	$P<0.001$
Albumin/globulin ratio	0·53± 0·03	0·77± 0·04	$P<0.02$
Haemoglobin (g/100 ml)	7·6 ± 0·5	6·5 ± 0·3	NS
Haematocrit (%)	36·8 ± 2·0	40·0 ± 1·0	NS
RBCC (millions/mm^3)	0·76± 0·03	1·09± 0·04	$P<0.001$
MCV (μm^3)	481·7 ±12·5	368·3 ± 7·9	$P<0.001$
MCH (pg)	97·4 ± 2·6	59·3 ± 2·2	$P<0.001$
MCHC (%)	20·5 ± 0·4	16·1 ± 0·4	$P<0.001$

NS, not significant.

Decrease in food intake, renal disturbances by uric acid accumulation and the possible decrease in transferrin levels (β-globulin) and protein–nucleic acid metabolism disorders could explain the abnormal erythropoiesis leading to microcytic hypochromic anaemia.

Blaxhall, P. C. & Daisley, K. W. (1973). *J. Fish. Biol.* 5, 771.
Sanchez Muniz, F. J., de la Higuera, M., Mataix, F. J. & Varela, G. (1977). *XVI Congreso Nacional de la SECF, Barcelona*, 138.

The relationship of the body mass index (W/H^2) to 12 year mortality in 3696 men from the west of Scotland. By V. M. HAWTHORNE, *Department of Community Medicine, University of Glasgow, Glasgow G12 8QQ* and J. WOMERSLEY, *Lanarkshire Health Board, District Office, 1 Main Street, Coatbridge, Lanarkshire ML5 3BN*

During routine visits in 1965 and 1966 by a Mass Radiography Unit, 3364 men employed in 13 different manufacturing industries in the west of Scotland completed a questionnaire and underwent a series of investigations concerning respiratory and cardiovascular fitness. Skilled and unskilled manual workers predominated, but some clerical and management workers were included. In addition 248 men from the Island of Tiree were investigated, and also 84 male relatives of the Tirean population who had been living on the mainland for some years.

The questionnaire covered name, date of birth, height (without shoes), weight (indoor clothes without shoes), smoking and exercise habits, and general health. The questionnaires were filled out by the volunteers and were checked through by a trained investigator who paid particular attention to resolving any doubt about the self-estimated height and weight.

A trace card was prepared for each examinee at the initial examination, and sent to the Registrar General for Scotland, who reports mortality amongst the volunteers at monthly intervals. The present study is concerned with the mortality occurring in the 3696 male volunteers over the 11 or 12 years from the time of the initial screening examinations until May 1977. No re-examination of the subjects was carried out during this interval.

The principal analysis involved the calculation of death rates for individuals grouped in quintiles of relative weight, using as an index the ratio W/H^2 (body mass index). Because of the negative association between cigarette consumption and body-weight, separate analyses were carried out for smokers and non-smokers.

The main findings were as follows: (1) The death rate for non-smokers below age 50 years who were not in the upper two quintiles of the body mass index was extremely low. (2) In both the non-smokers and the current smokers there was an approximately linear relationship between the body mass index and the death rate from cardiovascular disease. (3) There was no clear association between the body mass index and deaths from all causes in the non-smokers, current smokers or in the ex-smokers. (4) The relative risk of death for men in the upper two quintiles of the body mass index compared with men in the lower three quintiles, is of the same order as the relative risk for men with diastolic blood pressure 90 mm Hg or over compared with men whose diastolic blood pressure is 89 mm Hg or lower.

Flow and composition of bile in growing pigs. By I. E. SAMBROOK, *National Institute for Research in Dairying, Shinfield, Reading RG2 9AT*

Braude *et al.* (1976) reported that the quantity of digesta collected in 24 h from a re-entrant cannula sited in the duodenum of growing pigs, posterior to the bile and pancreatic ducts, amounted to 2·2–2·8 times dietary intake. In order to determine the contribution of bile to duodenal digesta, eight pigs with intact gall bladders and with re-entrant catheters inserted into the common bile duct (i.e. between the junction of the cystic and hepatic ducts and the point of entry into the duodenum) were used. These procedures greatly reduced the interference with normal physiological processes, that was usually encountered in earlier studies.

Two diets previously used by Braude *et al.* (1976) were fed; one was based on cereals and white fish meal (BWF), and the other was a semi-purified diet with casein as the sole protein source (SSC). The order in which the diets were fed to each pig was randomized and two 24 h collections were made on each diet.

Bile flow rate was calculated from the rate of formation of drops of bile in a small perspex drop-chamber. Drop formation rate was measured for one 3 min sample period every 15 min, and each hour's flow was calculated from the four constituent sample periods. Every 30 min a 0·5 ml sample of bile was taken to produce a representative 24 h pooled sample.

The mean flow of bile and some of its major components in 24 h are shown in the table.

Diet	Bile (g)	Water (g)	Dry matter (g)	Ash (g)	Total lipid (g)	Total nitrogen (g)
BWF	1733·0	1656·1	76·9	18·6	11·0	1·9
SSC	1181·5	1131·8	49·7	12·6	8·1	1·8

The mean 24 h flows of bile and of water, dry matter, ash, total lipid and total nitrogen in the bile, were all higher for diet BWF than for diet SSC. There was a marked difference between the diets in the pattern of hourly flow of bile over 24 h. Considerable short-term variation in flow rate between 3 min sample periods occurred, and rapid fluctuations in flow rate during sample periods were also observed. There was considerable variation between pigs in total 24 h flow of bile.

The mean concentration of dry matter and ash in the bile were similar for the two diets, while those of total lipid and total nitrogen were slightly higher for the diet SSC.

Braude, R., Fulford, R. J. & Low, A. G. (1976). *Br. J. Nutr.* **36**, 497.

The effect of milk substitute concentration on the intake of milk, dry feed and water by the calf. By J. H. TERNOUTH*, I. J. F. STOBO and J. H. B. ROY, *National Institute for Research in Dairying, Shinfield, Reading RG2 9AT*

Previously, we reported that Friesian bull calves had mean intakes of 689, 534, 440, 389 and 349 ml/kg live weight $(W)^{0.75}$ or 54·9, 57·8, 61·4, 65·2 and 68·0 g dry matter (DM)/$W^{0.75}$ when fed a milk substitute twice daily at concentrations of 80, 110, 140, 170 and 200 g DM/kg at 7–8 and 11–12 weeks of age (Ternouth *et al.* 1978). In the present communication, we report on the effect of giving the milk substitute at the five concentrations to the same calves once daily (9–10 weeks of age), and of offering dry feed and water *ad lib.* during the period 15–16 weeks of age when the milk substitute was offered once daily either to appetite (19 calves) or at a restricted rate (18 calves). Dry feed (a meal containing 12·5 MJ metabolizable energy/kg DM and 167 g crude protein (nitrogen×6·25)/kg DM) and water were offered from 12 weeks of age.

When the milk was given once daily, the intakes/$W^{0.75}$ were 73·0, 77·0, 79·8, 84·6 and 83·7% of those observed with twice-daily feeding, i.e. 39·4, 44·4, 48·8, 55·0 and 56·8 g DM/$W^{0.75}$, at the five concentrations respectively. Even at a concentration of 80 g DM/kg, calves were capable of increasing their milk intake at a single meal to approximately 16·0 l compared with 11·0 l/meal when fed twice daily. Comparable values for calves offered the milk containing 200 g DM/kg were 10·5 and 6·3 l/meal.

When milk was offered once daily to appetite, with dry feed and water freely available, the calves consumed 34·9, 40·3, 45·3, 50·8 and 46·6 g DM/$W^{0.75}$ as milk and 19·9, 7·5, 9·9, 5·5 and 8·1 g DM/$W^{0.75}$ as dry feed at the five milk concentrations. With restricted milk feeding, milk intake was 33·0, 34·7, 36·1, 35·8 and 38·2 g DM/$W^{0.75}$ and dry feed intake 24·7, 20·4, 15·2, 24·9 and 15·8 g DM/$W^{0.75}$. Restricting the intake of milk increased dry feed intake ($P<0.001$). Over-all, milk concentration had little effect on dry feed intake although when the 80 g DM/kg milk was fed the intake of dry feed was higher ($P<0.05$) than at higher concentrations. Total DM intake/$W^{0.75}$ was not related to milk concentration.

Water intake was highly variable between calves but was greater when the milk was fed at higher concentrations, mean intakes being 2·8, 3·6, 5·4, 6·4 and 9·1 l/d at the five concentrations. Water intake was not related to dry feed intake.

Ternouth, J. H., Stobo, I. J. F. & Roy, J. H. B. (1978). *Proc. Nutr. Soc.* (In the Press.)

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Body composition of women assessed by five methods. By P. G. PITTET, S. F. STALLEY, R. HESP and D. HALLIDAY, *Clinical Research Centre, Watford Road, Harrow HA1 3UJ*

The proportion of lean body mass (LBM) and fat (AT) was measured in 10 women (age 22–56 years, weight 62–133 kg) by 5 methods: body density (BD) assuming densities of 1·10 and 0·90 kg/m^3 for lean tissue and fat respectively (Deithelm *et al.* 1977), total body potassium (TBK) assuming 60 mmol K/kg LBM, skinfold thickness at 4 sites (SKT) by method of Durnin & Rahaman (1967), total body water (TBW) assuming 732 g water/kg LBM (Halliday & Miller, 1977) and the anthropometric measurements (AM) of Hume & Weyers (1971). Mean values for LBM (±SEM), the correlation coefficient (r) between pairs of methods, and the mean difference (D) (±SEM) between pairs of methods are given in the table. The mean LBM estimated by AM was significantly higher than by the other four methods, which generally agreed well among themselves, but TBW gave an estimate 2·26 kg greater than BD ($P<0·05$). There was a significant relationship between basal metabolic rate and body-weight (r 0·83, $P<0·05$), AT (r 0·824, $P<0·05$) and LBM (r 0·875, $P<0·01$). Finally, a highly significant correlation was found between TBW, measured by deuterium dilution, and the body surface area S (Du Bois & Du Bois, 1916): TBW (kg) = 14·04S (m^2) + 8·907; r 0·950; $P<0·001$.

Comparison of lean body mass (LBM) estimations by 5 methods in 10 women

Methods	LBM (kg)	BD	TBK	SKT	TBW	AM
Density (BD)	46·5±1·6		r=0·86**	r=0·85**	r=0·88***	r=0·74*
Potassium (TBK)	47·2±2·2	D=2·8 (0·7)		r=0·83**	r=0·89***	r=0·94***
Skinfolds (SKT)	47·6±2·6	D=3·3 (1·2)	D=3·3 (1·0)		r=0·92***	r=0·83**
Water (TBW)	48·8±1·9	D=2·8 (0·7)	D=2·4 (0·8)	D=3·0 (0·7)		r=0·90***
Anthropometric (AM)	52·3±2·3	D=6·0 (1·4)	D=5·8 (0·9)	D=4·9 (0·7)	D=3·5 (1·0)	

*$P<0·05$, **$P<0·01$, ***$P<0·001$.

This investigation had the approval of the Northwick Park Hospital Ethical Committee.

Diethelm, R., Garrow, J. S. & Stalley, S. F. (1977). *J. Physiol., Lond.* **267**, 14p.
Du Bois, D. & Du Bois, E. F. (1916). *Arch. Intern. Med.* **17**, 63.
Durnin, J. V. G. A. & Rahaman, M. M. (1967). *Br. J. Nutr.* **21**, 681.
Halliday, D. & Miller, A. G. (1977). *Biomed. Mass Spectrom.* **4**, 82.
Hume, R. & Weyers, E. (1971). *J. clin. Path.* **24**, 234.

The effect of preloads of varying energy density and methyl cellulose on hunger, appetite and salivation. By MERRIL L. DURRANT and P. ROYSTON, *Clinical Research Centre, Watford Road, Harrow HA1 3UJ*

Wooley *et al.* (1975) have described the use of the SHP Salivation test (Peck, 1959) for measuring appetite in response to palatable foods in human subjects. Saliva production was decreased in thin people 1 h after a 3·77 MJ preload, whereas in obese people it was not.

Twenty-six overweight patients (mean 97·4±21·3 kg) were admitted to a metabolic unit for a 3 week course of weight reduction on a protocol approved by the hospital Ethical Committee. On two test days a preload consisting of a soup, sandwich or milkshake of disguised energy content was given at 15.30 hours. Before eating patients were given a salivation test and asked to rate their hunger (physiological signals) and drive to eat (mental signals) on rating scales from 0–4. Patients recorded hunger and drive scores immediately after eating the preload and 1 h later when a second food was presented. A second salivation test was made before eating the second food and they were asked to estimate the energy content of the preload.

Thirteen patients were given preloads of 0·42 MJ or 1·26 MJ on one of each of the paired days. Thirteen patients were given preloads of 0·84 MJ on both days with an additional 1 g methyl cellulose (MeCe) with 100 ml water on one of the days.

Parameter	0·42 MJ	1·26 MJ	0·84 MJ	0·84 MJ+MeCe
Preload salivation (g)	1·71± 0·78	1·70± 0·86	1·32± 0·74	1·61± 0·97
Intermeal hunger score	2·8 ± 1·7**	1·9 ± 2·1	1·5 ± 1·6	1·5 ± 1·5
Intermeal drive score	3·5 ± 1·8	3·2 ± 2·1	1·9 ± 1·4	1·9 ± 1·8
Test salivation (g)	1·68± 0·73**	1·45± 0·71	1·17± 0·68	1·40± 0·69*
Estimates (k cal)	185±69	200±71	200±58	192±49
Estimates (MJ)	0·77±0·29	0·84±0·30	0·84±0·24	0·80±0·21

*Significant at 5%, **Significant at 4% or less.

Using the Fisher randomization test patients were significantly more hungry (P=0·04) after the low compared with the high preload. Drive scores were not significantly different. There were no significant hunger and drive score differences during the methyl cellulose trial.

All values of salivation weight were transformed by log e for normalisation and variance stabilisation. Salivation was significantly higher (t 2·45, P=0·03) after the low compared to the high preload. This reinforces the hunger score results that the patients were sensitive to small differences in energy intake. Salivation was just significantly higher on the methyl cellulose compared with the isoenergetic preload (t 2·15, P=0·05). Thus *a fortiori* the rating scales and salivation tests revealed no appetite reducing effects due to the methyl cellulose and water drink. Patients were unable to estimate differences in energy content of preloads and the methyl cellulose was not associated with increased estimates.

Peck, R. E. (1959). *Archs gen. Psychiat.* **36**, 51.
Wooley, O. W., Wooley, S. C. & Woods, W. A. (1975). *J. comp. physiol. Psychol.* **89**, 619.

The diet of ten families living in a Himalayan village in India. By ROSEMARY SCOTT (Introduced by E. M. WIDDOWSON), *Newnham College, Cambridge*

In the summer of 1976 two Cambridge students lived in a Himalayan village in the province of Garwahl and Kumaon, for one month. With the aid of an interpreter, the women in 10 representative families out of a total of 55 were interviewed. When good relations had been established, food intakes of the families were measured over a period of 4 d. The composition of the families was known, and the recommended intake of each nutrient for the whole family was calculated using both Indian and British standards. The intakes of nutrients for each family were calculated from Indian food tables and compared with both sets of family requirements. The adequacy or otherwise of the diet in respect of some nutrients depended on the standards used. The Indian recommended intakes are higher than the British for iron, B vitamins and vitamin C, lower for energy and protein and about the same for calcium and vitamin A. However, intakes of energy, calcium, vitamin A and riboflavin were low whichever standard was adopted. Individuals of all ages were short and lean, and the intakes per kg body-weight might have made a much better showing.

The traditional staple foods of the village were, until recently, wheat, buckwheat and various types of millet. Rice, which cannot be grown due to the altitude, is bought by barter in the nearby town. Better transport has brought with it cheaper rice, and this had led to an increase in the consumption of rice, which is usually polished. The diet has probably suffered thereby.

As many as possible of the children of 5 years and under in the village, amounting to 37 boys and girls, were weighed. They were light even when compared with Indian standards, and fell even farther behind when British or American standards were used. One child aged 2·5 years was obviously malnourished. It was very small, had reddish hair, the anterior fontanelle was still open and it had bow legs. Children in the village were normally breast fed until about 6 months, then started eating solid food, usually rice, chewed chapatty or potato, but continued to take their mothers' milk until the advent of the next child, which was sometimes several years later. The malnourished child had received no milk from its mother and had subsisted largely on cereal together with any breast milk other women were willing to provide.

Guar gum and glucose absorption: absence of evidence for malabsorption.

By A. R. LEEDS*, N. BOLSTER and A. S. TRUSWELL, *Department of Nutrition, Queen Elizabeth College, London W8 7AH*

Guar gum, a galactomannan derived from the Cluster bean (*Cyamopsis tetragonoloba*), has recently been shown to decrease postprandial glycaemia and urinary glucose loss in diabetics, following incorporation of the gum into meals. These observations may be indicative of slower rates of glucose absorption and possibly glucose malabsorption. (Jenkins *et al.* 1977).

Hydrogen can be synthesized by colonic bacteria utilizing malabsorbed carbohydrate substrates. Absorbed H_2 exchanged into alveolar air may be quantitated by collection and analysis of expired air by gas chromatography. The H_2 concentration in single end-expiratory breath samples correlates well with total H_2 expired and the latter correlates well with total H_2 evolved within the gut lumen (Bond & Levitt, 1977).

In this experiment end-expiratory breath H_2 determinations were made at 0·5 h intervals for 5 h on 5 healthy female volunteers (aged 21–25 years, body-weight range: 94–120% of ideal) who, after an overnight fast ate a meal composed of 50 g glucose, 12 g Guar gum (supplied by Hercules Powder Co.) and 400 ml water. The test was preceded in each case by experiments to ensure that the subject did not produce H_2 by malabsorbing glucose (50 g glucose in 400 ml water), did not ferment Guar gum alone with evolution of H_2 (12 g Guar gum in 400 ml water), and did evolve H_2 from an unabsorbable galactose-fructose dissacharide (Lactulose^R) in the presence of Guar gum (12 g Guar gum, 25 g Lactulose, 400 ml water). Only those subjects who fulfilled the required conditions proceeded to the Guar gum glucose test.

All 5 subjects did not produce H_2 after the 50 g glucose drink, nor after 12 g Guar gum. All 5 had measurable breath H_2 after 25 g Lactulose–12 g Guar gum, the mean ($\pm$SEM) of the time of first appearance of H_2 being 102$\pm$20 min. All 5 subjects did not produce H_2 after 50 g glucose–12 g Guar gum.

The absence of H_2 production after the glucose and Guar gum meal suggests that no glucose was malabsorbed. However, it is possible that Guar gum inhibited bacterial production of H_2 by fermentation of glucose. Evidence from in vitro faecal homogenate fermentation studies indicates that Guar gum does not inhibit H_2 production, and the results of the Guar gum–Lactulose tests show that H_2 is evolved from Lactulose in the presence of Guar gum. It remains possible that transit was slowed such that malabsorbed glucose reached the caecum after 5 h.

These results support the idea that while Guar gum reduces the magnitude of post-prandial glycaemia this is not necessarily an indication that absorption is incomplete.

The authors are grateful to the volunteers for their help.

Jenkins, D. J. A., Wolever, T. M. S., Hockaday, T. D. R., Leeds, A. R., Howarth, R., Bacon, S., Apling, E. C. & Dilawari, J. (1977). *Lancet* ii, 779.
Bond, J. H. & Levitt, M. D. (1977). *Digestive Dis.* **22**, 379.

*Heinz Research Fellow.

Cortisol effects on protein utilization in growing rats. By OLGA MOREIRAS-VARELA, G. VARELA and M. DE LA HIGUERA, *Instituto de Nutrición (CSIC), Facultad de Farmacia, Madrid-3, Spain*

Wistar rats of an average weight of 75 g were given the usual laboratory diet with about 20% protein content (biological value, 67). For endogenous nitrogen determinations a 4% protein diet (casein +5% D, L-methionine) was used. Groups of 12 animals were maintained in individual metabolism cages for balance experiments based on the Thomas–Mitchell technique. Cortisol, suspended in NaCl (9 g/l), was daily given intramuscularly at the levels of 0·2 mg (A), 0·4 mg (2A) and 0·8 mg (4A)/100 g body-weight. Controls (C) were given sham injections of an isotonic solution of NaCl (9 g/l). Hormonal treatment coincided with excreta collection periods.

	Food intake (g DM/rat per d)	Wt increase (g/rat per d)	Apparent digestibility coefficient	True digestibility coefficient	Biological value
C	9·3±0·2	3·8±0·1**	83·2±0·5	86·7±0·5	67·1±1·0**
A	9·2±0·3	2·7±0·3**	82·2±0·5	86·2±0·4	52·6±1·9**
2A	8·7±0·3	1·7±0·2**	81·8±0·5	85·8±0·5	45·8±1·3**
4A	8·2±0·2*	0·4±0·2**	83·0±0·8	86·5±0·4	43·9±1·4**

*Significantly different from C and A: $P<0·01$
**Significantly different from the other three groups: $P<0·01$.

Cortisol effect, on decreasing food intake, became significant for dose 4A. That decrease could be explained as a result of metabolite action (mainly glucose and amino acids) on hypothalamic centres controlling food intake. Body-weight changes reflect the results obtained for biological value (BV). Apparent and true digestive efficiency was not modified by cortisol administration. Nevertheless, when endogenous faecal nitrogen was determined, cortisol was found to increase it proportionally to dose. This effect would be the result of an increased 'leaking' towards the intestinal lumen of some serum proteins, especially albumin. A significant decrease of the apparent digestibility coefficient has been found in pregnant rats when cortisol was administered daily throughout pregnancy (Varela *et al.* 1977). Dietary nitrogen utilization (BV) was shown to be very sensitive to cortisol dose. Endogenous urinary nitrogen increased in response to hormonal treatment but not to cortisol dose. On the other hand, total urinary nitrogen was significantly different for any group and was dependent on cortisol dose. BV significantly decreased when the rats were treated with cortisol and that effect was also dose dependent. Similar results has been reported previously for higher doses (Moreiras-Varela & Varela, 1972). From the results obtained for BV it would be possible to get an approximate calculation of cortisol action on endogenous and dietary nitrogen separately.

Moreiras-Varela, O. & Varela, G. (1972). *Rev. esp. Fisiol.* **28**, 91.
Varela, G., Mejias, M. V., de la Higuera, M. & Urbano, G. (1977). *Nutr. Metab.* **21**, 215.

Energy metabolism during short-term starvation. By K. ROSENBERG and J. V. G. A. DURNIN, *Institute of Physiology, University of Glasgow, Glasgow*

In famine situations, women frequently have a lower mortality than men (c.f. Keys *et al.* 1950; Widdowson, 1976). Sex-related differences in animals exposed to undernutrition have also been reported (Widdowson, 1976). It is possible that such differences, at least in part, are due to a difference in the fuels metabolized: females may be more efficient in the utilization of stored fat, thus effectively sparing the functionally more important body protein.

We have carried out experiments to investigate this possibility. Ten young men and ten young women completed a three day total fast. Water was allowed *ad lib.* During the fast, and for the preceding 24 h, all urine was collected and analysed for total nitrogen. In addition, body composition was assessed by densitometry and skinfold thickness, daily energy expenditure was estimated by a timed activity diary, and resting metabolic rate was measured on each of the 3 d of the fast.

Protein catabolism, as reflected by N excretion, is compared between men and women in Table 1 according to various conventions of standardization. There is no significant difference between men and women. Protein metabolism provided 18% of basal energy for the men on the third day of the fast and 17% for the women.

When the data from the men and the women was combined and subjected to regression analysis, the best single predictor of N excretion on the third day of the fast was found to be fat free mass (r +0·86). Stepwise multiple regression analysis with fat free mass, basal energy expenditure, urine volume and fat percentage resulted in a multiple correlation coefficient of +0·94 between these variables and nitrogen excretion.

Although during this 3 d total fast there were no sex-related differences in the level of N excretion, it is possible that some measure of dehydration and the comparatively homogenous body fat contents of the subjects may have introduced some bias in the results.

This experiment was approved by the Committee of Medical Ethics.
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Table 1. *Mean standardized urinary nitrogen excretion for men and women*

		g N/kg body-wt	g N/kg fat free mass	basal kcal/g N	g N/m^2
Day 0	men	0·18	0·22	162	6·86
	women	0·17	0·23	152	6·23
Day 1	men	0·15	0·18	182	5·71
	women	0·15	0·19	180	5·31
Day 2	men	0·16	0·19	179	5·87
	women	0·14	0·18	191	5·01
Day 3	men	0·18	0·22	143	7·10
	women	0·18	0·23	148	6·40

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Biochemical adaptations in early starvation: Observations on sex difference. By J. BROOM, A. FLECK and D. F. DAVIDSON, *Department of Pathological Biochemistry, Western Infirmary,* and C. ROSENBERG and J. V. G. A. DURNIN, *Department of Physiology, University of Glasgow, Glasgow*

The same group of students as described previously by Rosenberg & Durnin (1978) were used to follow changes in biochemical parameters in the early phase of starvation in normal man. Twenty-two students, eleven male and eleven female, volunteered to fast for 3 d. Twenty-four hour urine collections were obtained over the period of study, and total nitrogen, urea, and 3-hydroxybutyrate (3-OH-butyrate) were determined in each. Pre-lunch blood samples were taken on day zero and at midday on day three: plasma glucose, serum urea, 3-OH-butyrate, total protein, albumin, retinol binding protein (RBP), pre-albumin, C-reactive protein (CRP) and other acute phase reactants were measured.

Male to female groups showed a marked reduction in urine volume over the three days and a slight rise occurred in serum total protein and albumin. Both groups showed a fall in plasma glucose over the period of study. RBP concentration in plasma fell, the day 3 level being 16% lower than day zero. This was the only plasma protein to demonstrate such an effect. Other acute phase reactants showed no change in this period, CRP remained undetectable throughout.

The change in plasma 3-OH-butyrate showed significant sex differences. The ratio serum urea to serum 3-OH-butyrate showed a twofold difference between the groups, the males having the higher ratio. This was also reflected in the degree of ketonuria, the females showing a fivefold increase in 24 h urinary output of 3-OH-butyrate over the male group.

This difference in the metabolic response to fasting might be related to the clear sex differences in body composition, the possible lesser loss of urinary N after injury in mildly ketonaemic patients (Wedge *et al.* 1976) and the more marked metabolic response to injury in the male.

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