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Abstracts of Original Communications

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The stability of food intake between adolescence and adulthood: a 21-year follow-up. By A.M. CRAIGIE, A.A. LAKE, C. WOOD, M. GIBBONS, S. WEBSTER, A.J. ADAMSON, A.J. RUGG-GUNN and J.C. MATHERS, *University of Newcastle, Human Nutrition Research Centre, Wellcome Research Laboratories, RVI, Queen Victoria Road, Newcastle upon Tyne NE1 4LP*

Studies of the diet of adolescents in the UK demonstrate that dietary habits known to be detrimental to health in adulthood are evident at an early age. For example, Gregory *et al.* (2000) found 4–18-year-olds in the UK to have a frequent consumption of fatty and sugary foods and a low consumption of fruit and vegetables. Concerns have therefore been expressed regarding the diet of children and adolescents and the continuation of these dietary habits into adulthood (HEA, 1995; Gaziano, 1998). This study aimed to investigate the extent to which these concerns may be justified by determining the stability of food intake in a group of adolescents followed up 21 years later in adulthood.

The investigation involved 202 individuals from whom dietary data were collected in 1979–80 (mean age 11.6 years) (Hackett *et al.* 1984) and again in 2000–1 (mean age 32.5 years). Dietary data were collected at both time-points using two 3 d estimated food diaries followed by an interview to determine portion sizes, using the method considered most appropriate at the time, i.e. calibrated food models in 1979–80 and a photographic food atlas (Nelson *et al.* 1997) in 2000–1. Foods consumed were allocated to one, or a combination of, the five food groups of the 'Balance of Good Health' food selection guide (HEA, 1994) according to Gatenby *et al.* (1995). The weight of food eaten from each of the five food groups was calculated (percentage of total weight of food consumed) and Pearson correlation coefficients generated to provide an estimate of the stability of food intake.

	11.6 years % Total food weight		32.5 years % Total food weight		11.6 years *v.* 32.5 years	
	Mean	SD	Mean	SD	Pearson correlation coefficient	*P*
Bread, other cereals and potatoes	30.4	7.0	29.9	6.8	0.24	<0.01
Foods containing fat and/or sugar	21.1	6.1	12.3	6.2	0.01	0.84
Fruit and vegetables	14.6	6.5	25.1	10.8	0.25	<0.01
Meat, fish and alternatives	16.7	5.3	17.1	6.4	0.17	0.02
Milk and dairy products	17.2	7.6	15.6	7.9	0.10	0.16

The HEA guide advises that a balanced diet should consist of around 33% fruit and vegetables, 33% bread, other cereals and potatoes, 8% foods containing fat and/or sugar, 12% meat, fish and alternatives and 15% milk and dairy products (Gatenby *et al.* 1995). A shift in the group's food intake towards the recommendations had occurred with age, most notably with a decrease in foods containing fat and/or sugar and an increase in fruit and vegetables. Nevertheless, at both ages, intakes of foods containing fat and/or sugar, meat, fish and alternatives were higher, and fruit, vegetables, bread, cereals and potatoes lower, than currently recommended. In addition, although there was significant evidence of tracking of relative intake of bread, other cereals and potatoes ($P<0.01$), fruit and vegetables ($P<0.01$), and meat, fish and alternatives ($P=0.02$) between 11.6 and 32.5 years, the correlations were not strong.

In conclusion, food intake patterns had changed considerably from early adolescence through to adulthood in a direction more in line with the current recommendations. The predictive value of an adolescent's food intake of their intake in adulthood was found to be significant, but not strong. Further investigations will consider the extent to which this is influenced by factors as such social class, gender and educational level as well as assessing tracking in terms of relative nutrient intake.

The project was funded by The Wellcome Trust (057995/Z/99/Z).

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Aggregation of diets containing fatty and sugary foods and fruit and vegetables within cohabiting couples. By A.A. LAKE, A.M. CRAIGIE, C. WOOD, M. GIBBONS, A.J. RUGG-GUNN, J.C. MATHERS and A.J. ADAMSON, *University of Newcastle, Human Nutrition Research Centre, Wellcome Research Laboratories, RVI, Queen Victoria Rd, Newcastle upon Tyne NE1 4LP*

Marriage and cohabitation brings together two independent food choice systems. Within this new system spousal preferences have an influence on both partners' food choices and nutritional intakes for an extended time period (Sobal *et al.* 2000). There is also a symbolic importance drawn from the fact that couples are eating together, as well as the complex issues of power and control over food choice, food purchase and preparation. This unit has the potential to influence eating patterns in children and may be an appropriate target for health promotion messages.

Dietary data were collected from eighty pairs of cohabiting partners. The individuals ranged in age from 21.4 to 45.2 years and were living within Tyne and Wear and Northumberland (70%) and throughout the rest of the UK (30%). Food intake data were collected at the same time for each partner, between 2000 and 2001, using two 3 d food diaries compiled approximately 6 months apart. A trained nutritionist interviewed the couples within 3 d of completing each diary and quantities of foods were estimated using a photographic food atlas (Nelson *et al.* 1997). Foods were assigned one of five food categories from 'The Balance of Good Health' food guide (HEA, 1994) according to Gatenby *et al.* (1995).

This analysis examines the dietary intake of the couples, by gender, examining their percentage contribution of foods containing fat and/or sugar and fruit and vegetables to their total food weight consumed. The mean percentage contribution of foods containing fat and/or sugar to total food weight consumed by males was 14.2% (SD 7.6, 95% CI 12.5–15.9) and lower for females, 12.4% (SD 6.3, CI 11.0–13.8). The percentage contributions were ranked and divided into tertiles, separately for men and women, and partners were compared as shown below.

Distribution of partners amongst tertiles for fat and/or sugar contributions to food weight

		Female partner		
		Lower tertile	Middle tertile	Upper tertile
Male partner	Lower tertile	12	9	5
	Middle tertile	7	13	7
	Upper tertile	7	5	15

Fruit and vegetables provided a higher proportion of intake for females than for males, 26.9% (SD 10.2, CI 24.6–29.2) and 21.5% (SD 9.0, CI 19.5–23.5), respectively.

Distribution of partners amongst tertiles for fruit and vegetables contributions to food weight

		Female partner		
		Lower tertile	Middle tertile	Upper tertile
Male partner	Lower tertile	17	4	5
	Middle tertile	7	13	7
	Upper tertile	2	10	15

Pearson's correlations were used to measure the strength of association between food group intakes between men and women. Significant correlations were seen for intakes of fatty and sugary foods ($P<0.01$, r +0.531) and for fruit and vegetables ($P<0.01$, r +0.566).

Previous work has indicated strong links between the diets of spouses or cohabiting adults (Kemmer *et al.* 1998). This work indicates that there are strong correlations between intake of the groups of foods containing fat and/or sugar and, in particular, fruits and vegetables consumed by couples. Further work examining the dynamics of the food relationship within families, social influences and correlations between dietary habits of couples and of parents and children is in progress.

This project was funded by the Wellcome Trust (057995/Z/99/Z)

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The development and pilot evaluation of a pregnancy nutrition education intervention programme ('Food For Life') for women aged 16–18 years. By W.L. WRIEDEN[1] and A. SYMON[2], [1]*Centre for Public Health Nutrition Research,* [2]*School of Nursing and Midwifery, University of Dundee, Ninewells Hospital and Medical School, Dundee DD1 9SY*

Improved nutrition during pregnancy can benefit maternal and infant health, and may influence long-term eating patterns for the whole family. The Scottish Diet Action Plan for Health (Scottish Office, 1996) has commented that "In view of the significance of nutrition in pregnancy for the future health of the child, innovative ways of providing practical support to women on low incomes should be considered". An informal food skills intervention programme led by midwives is one way of providing this support. The aim of the 'Food for Life' project was to develop and evaluate such a nutrition education programme. Objectives included determining whether standard dietary assessment methods could be employed in this group, as well as the size of trial that would be required to demonstrate effectiveness in terms of dietary behaviour.

A pilot intervention package was developed and two midwives were recruited and trained to run the course. The package was offered to women aged 16–18 years, presenting with their first pregnancy. Sessions were offered weekly for a 7-week period starting October 2000, January and March 2001 in Perth and Dundee. Interview schedules were developed to collect data on socio-demographic details, dietary intake and cooking skills. The interview schedules were administered by a research assistant at the start and the completion of the course and included an eating habits questionnaire and a 24-h dietary recall. Incentives included shopping vouchers, reimbursement of travel expenses and free food packages to take away. An additional single 1 d course was also offered, using material from the longer course. Participants in this case were interviewed, assessments carried out as before, and this was followed by a focus group discussion.

The midwives reported that the package was easy to follow and use. The teenagers who attended the courses reported that they were useful and enjoyable. Out of an anticipated thirty-six teenagers, ten attended one of the six 7-week courses and a further six women attended the 1 d course. Thus sixteen women completed baseline assessments. Only three completed the post-intervention assessments. The teenagers commented that they had difficulty in completing the eating habits questionnaires. Subsequent analysis found a mismatch between the results of this questionnaire and recall of the previous day's food intake (e.g. nine subjects claimed to eat fruit every day but only two recorded it on 24-h recall). However both methods found that the teenagers consumed sweets and crisps more frequently than fruit (five, seven and two subjects recorded eating sweets, crisps and fruit, respectively, on the previous day). To see a statistically significant increase of one portion of fruit and vegetables per day in a controlled trial it is estimated that 400 subjects need to be recruited (which allows for a 50% drop-out rate).

The nutrition education programme developed for teenage pregnant women was favourably received by midwives and the small number of teenagers who participated. However recruitment to the programme was problematic despite a wide range of incentives. Alternative methods of delivering such a package should be investigated. The use of standard dietary assessment procedures in the form of an eating habits or food frequency questionnaire is not advised for this group but the use of successive 24-h recalls of food intake should be evaluated.

This work was funded by the Chief Scientist's Office of the Scottish Executive Department of Health and by Asda stores.
With thanks to Moyra Crichton for developing the package, and midwives Joan Chynoweth and Fiona Little.

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Use of the theory of planned behaviour to predict intention of complete denture wearers to eat more fruit and vegetables. By J. BRADBURY, J.M. THOMASON, N.J.A JEPSON, A.W.G. WALLS, P.F. ALLEN and P.J. MOYNIHAN, *The Dental School, University of Newcastle upon Tyne, Newcastle upon Tyne NE2 4BW*

Complete denture wearers tend to have a lower intake of fruit and vegetables and a decreased chewing ability compared with people with a functional dentition (Moynihan & Bradbury, 2001). However, a number of studies showing improved chewing ability with fixed, implant-supported dentures have failed to demonstrate any significant change in diet (Sandstrom & Lindquist, 1987; Sebring *et al.* 1995), suggesting that factors other than chewing ability may also be influential in this group.

The aim of this study was to use the theory of planned behaviour (TPB) to examine the associations between beliefs, attitude, subjective norm (SN), perceived behavioural control (PBC) and intention to eat more fruit and vegetables in complete denture wearers. Seventy-nine patients (fifty-three female, twenty-six male, aged 45–79 years, mean 67 years), attending Newcastle Dental Hospital for replacement dentures, completed a self-administered questionnaire. Statements were scored on a 7-point scale (–3 to +3). Beliefs were multiplied by their corresponding outcome statements (scored 1 to 7), summed, and a mean calculated for each patient. A higher score indicated a more positive belief. The association between habit ('what I eat has not changed very much over the past year') and intention was also assessed. Spearman's rank correlation coefficients were calculated to examine the strength of the relationships.

For fruit, behavioural, normative and control beliefs were positively correlated with attitude, SN and PBC. Attitude, SN and PBC were positively correlated with intention to eat more fruit. For vegetables, behavioural, normative and control beliefs were positively correlated with attitude, SN and PBC. Unlike fruit, attitude, SN and PBC were not correlated with intention to eat more vegetables. Behavioural and normative beliefs were predictive of intention to eat more fruit. Normative beliefs only were predictive of intention to eat more vegetables.

Fruit	Attitude		SN		PBC		Intention	
	R	*P*	*r*	*P*	*r*	*P*	*r*	*P*
Behavioural beliefs	0.589	0.000**	–	–	–	–	0.442	0.000**
Normative beliefs	–	–	0.655	0.000**	–	–	0.443	0.000**
Control beliefs	–	–	–	–	0.292	0.012*	0.143	0.210
Intention	0.537	0.000**	0.294	0.011*	0.206	0.068	–	–

Vegetables	Attitude		SN		PBC		Intention	
	R	*P*	*r*	*P*	*r*	*P*	*r*	*P*
Behavioural beliefs	0.617	0.000**	–	–	–	–	0.164	0.147
Normative beliefs	–	–	0.423	0.000**	–	–	0.260	0.022*
Control beliefs	–	–	–	–	0.403	0.000**	-0.155	0.172
Intention	0.056	0.624	0.176	0.134	0.117	0.303	–	–

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

Habit was not significantly correlated with intention to eat more fruit ($r=0.100$, $P=0.382$), but was negatively correlated with intention to eat more vegetables ($r=-0.233$, $P=0.039$), suggesting that the more that denture wearers agreed that their diet had not changed much over the past year, the less likely they were to intend to eat more vegetables.

Behavioural and normative beliefs, and attitude and SN, showed reasonably strong correlations with the intention to eat more fruit. This was not the case for vegetables, suggesting that in this group of people, the TPB was a better predictor of intention to eat more fruit than vegetables.

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The development and evaluation of a school-based approach to increasing vegetable intake in schoolchildren. By K.L. BARTON[1], A.S. ANDERSON[1], A. WOODCOCK[2], E. ROBERTSON[3], P. McCAFFREY[4] and L.E.G. PORTEOUS[1], [1]*Centre for Public Health Nutrition Research, University of Dundee, Dundee DD1 9SY,* [2]*Specialist Health Promotion Service, Dundee DD3 8EA,* [3]*Education Department, Dundee City Council, Dundee DD1 3RJ and* [4]*Tayside Contracts, Dundee DD3 8SS*

Recent work from the National Diet and Nutrition Survey of young people aged 4–18 years has highlighted low (and decreasing) intakes of vegetables (Department of Health, 1989; Gregory *et al*. 2000). Although there are few estimates of total vegetable intake in young people in the school meals setting, Wrieden *et al.* (2000) has shown that vegetables are far from a popular choice and more recent work by Anderson *et al.* (2001) has demonstrated that the provision of increased fruit and vegetables in schools, coupled with an education programme, has resulted in increased uptake in fruit but not vegetables in primary-school children. The aim of the study was to develop and test the feasibility of a combined catering and education initiative focusing on the provision of salad-bar facilities in secondary schools, as a route to increasing vegetable consumption.

Following formative research (including observing current models of practice in other health board areas, and assessing service staff, consumer views and costs), salad-bar facilities and a promotional programme were introduced for an 8-week period during the summer term of 2001 at one secondary school in Dundee. Evaluation measures were undertaken pre- (T0), during (T1) and post-intervention (T2) in the intervention school (IV) and in one control school (C) in a similar socio-demographic area. Methods included observation and recording of vegetable (portion) choices at school meals and observations of waste by three independent researchers in the dining areas at three time points. Verbal feedback from consumers and catering staff, and catering cost assessments were also obtained.

Catering staff required support and encouragement to develop and maintain provision, but overall, the facility was reported to be a useful and practical adjunct to catering. A total of 276 (IV) and 216 (C) observations of individual meal choices were made before the 7 weeks of school intervention and 233 (IV) and 210 (C) after. The results indicated that the numbers of individuals who did not consume vegetables had *decreased* significantly (from 61% to 52%, $P<0.01$) in the intervention school, whilst *increasing* significantly (from 73% to 79%, $P<0.05$) in the control school over the same period. In both schools, the number of 'higher' consumers decreased significantly, possibly due to the absence of senior pupils during the examination period.

Percentage of vegetables...	T0		T1		T2		Intervention effect	
Consumers	IV	C	IV	C	IV	C	IV	C
Non-consumers	61	73	64	80	52	79	↓ **	↑ *
Low consumers	15	13	20	14	27	8	↑ **	↓ *
Moderate consumers	24	15	16	6	21	13	↓ **	↓ *
All consumers	39	28	36	20	48	21	↑ *	NS

*$P<0.05$; **$P<0.01$.

In conclusion, more than half the children observed did not choose to eat vegetables at school lunches. Following a simple salad-bar intervention, the proportion of children eating any vegetables increased significantly, although it continued to decline in a control school. This type of intervention where choice is clearly available should be further developed as an opportunity for increasing vegetable consumption in teenage children and the dietary implications should be assessed.

The research was funded by Tayside Health Board, Health Improvement Fund. The views expressed are the authors' own.

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A shelf-stable, palatable test meal suitable for use with hydrophilic and lipophilic tracers in ^{13}C breath tests. By C. SLATER[1], T. PRESTON[2], D.J. MORRISON[1] and L.T. WEAVER[1], [1]*Department of Child Health, University of Glasgow, Yorkhill Hospitals, Glasgow G3 8SJ and* [2]*Isotope Biochemistry Laboratory, Scottish Universities Environmental Research Centre, East Kilbride G75 0QF*

^{13}C breath tests have been developed to measure the rate of gastric emptying, digestion, absorption and fermentation of ingested food. They are conceptually simple and avoidance of a radiation hazard makes them suitable for the study of children and pregnant women (Amarri & Weaver, 1995). The subject consumes a test meal containing a ^{13}C-labelled substrate. The labelled substrate is selected on the basis that hydrolysis of a target bond releases the ^{13}C label, which eventually appears in breath CO_2. Breath is sampled before consumption of the test meal and at intervals afterwards. There is no standardization of protocols for ^{13}C breath tests (Harding & Coward, 1998) and differences in the test meal, for instance in macronutrient composition and energy density, make direct comparisons between tests difficult. We have developed a test meal suitable for ^{13}C-breath tests, which can carry both lipophilic and hydrophilic substrates.

The test meal is composed of 90 g rolled oats, 40 g honey and 40 g butter (weighed to within 1 g). The honey and butter are melted over a bain-marie. The tracer (weighed to 0.001 g) is stirred into the melted ingredients until dissolved and distributed evenly. The oats are added and the mixture stirred thoroughly until all the liquid is absorbed. The mixture is spread over the bottom of an aluminium foil-lined tray (160 mm square or 170 mm diameter), and baked at 130° for 15 min in a fan-assisted oven. The bowls, spoons, baking tray and foil were weighed before and after use.

^{13}C-mixed triacylglycerol (MTG), ^{13}C-acetate, ^{13}C-octanoic acid (sodium salt) and lactose ^{13}C-ureide (LU) breath tests have been performed using this test meal in healthy subjects aged from 5 to 50 years. The cumulative percentage dose recovered (cPDR) in each breath test was calculated using a predicted value of CO_2 production rate (Shreeve *et al*. 1970).

Breath test	Test duration (h)	Adult *n* (F:M)	Adult (age 21–50 y) cPDR (Mean (SD))	Child *n* (F:M)	Child (age 5-15 y) cPDR (Mean (SD))
MTG	9	8 (2:6)	42.9 (4.3)	8 (4:4)	29.0 (5.6)
Acetate	6	8 (2:6)	33.0 (7.2)	8 (4:4)	28.1 (5.3)
Octanoate	9	4 (2:2)	47.2 (5.4)	–	–
Lactose ureide	24	2 (1:1)	42.7 (3.1)	–	–

MTG is lipophilic and dissolves in the lipid phase of the butter. ^{13}C-sodium acetate, ^{13}C-sodium octanoate and LU are hydrophilic and dissolve in the aqueous phase of the butter and honey. The test meal is nutritionally balanced (6 g protein, 53 g carbohydrate and 24 g fat per 100 g) and all the participants found it palatable. The test meal can be stored for several months in an airtight container and divided into portions, depending on the size of the recipient. This recipe provides approximately 17% of the daily energy needs of two adults. It also has the advantage of being gluten-, egg- and lactose-free. *In vitro* studies confirmed that ^{13}C-acetate and ^{13}C-octanoate were distributed evenly within the test meal and were not lost during cooking. A similar test meal was used by Meier-Augenstein *et al*. (2001) to measure gastric emptying of solids, but we substituted syrup derived from a C_4 plant with honey derived from C_3 plants, so that our test meal had low ^{13}C abdundance (Morrison *et al.* 2000). A constant and low ^{13}C background is more important when cPDR (area under curve) is the calculated end-point, rather than for kinetic studies, where the measured end-point is related to rate of ^{13}C appearance.

This test meal can carry a range of both hydrophilic and lipophilic substrates, which may be important when comparing the results of more than one test, for example acetate corrections to ^{13}C-MTG breath tests (Slater *et al*. 2001), as there will be no effect of differences in test meal. It has proved to be acceptable to people of all ages.

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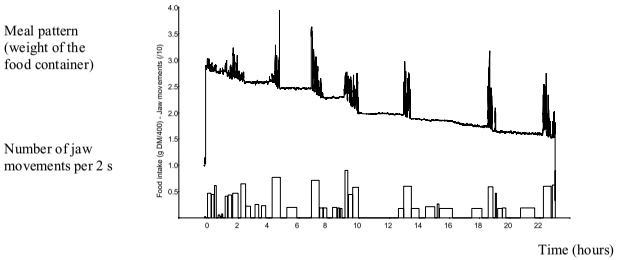
Estimation of food intake through chewing analysis in free-grazing animals. By F.F. BERMÚDEZ[1], J.J. AMOR RANEDO[2] and J.P. BARRIO[3], [1]*Estación Agrícola Experimental de León (CSIC), Grulleros, León, Spain,* [2]*Industrias de Nutrición Animal S.L., Corbillos de la Sobarriba, 24228 León, Spain and* [3]*Departamento de Fisiología, Universidad de León, 24071 León, Spain*

A method for the estimation of food intake by grazing animals, using halters bearing elastic conductive rubber tubing, has been developed, based on previous work by Penning (1983). A coiled wire connects the transducer to a self-contained embedded computer (TDS2020; Triangle Digital Services, Harlow, UK) including a 9 V power supply, A/D ports and 2-Mb memory card. The assembly was fastened with a harness to the backs of four Churra ewes kept in a waterproof enclosure.

The voltage signal coming from the jaw movement transducers (about 50 mV) is fed to the TDS2020 board. A Forth program stored in the ROM of the Hitachi processor, based on that described by Beauchemin *et al*. (1989), is used to record, store and analyse the chewing-wave data. The sampling interval is set to 16 Hz, to ensure the detection of enough data on each chewing wave. A threshold amplitude was predefined in order to prevent undesirable fluctuations. When the difference between two consecutive data values is higher than this threshold value, a possible chewing activity is considered and the sign of the difference is evaluated. The changes in the sign of the successive differences indicate that the maximum or minimum levels of a chewing wave have been reached, and these are detected and stored by the program. Two consecutive sign changes indicate a complete jaw movement. The program takes a count of the number of jaw movements happening in a 2-s period, and this value is stored in the memory card. A 7-segment LED display also receives the chewing frequency data for visual feedback.

From the number of jaw movements per time unit it is possible to detect the type of chewing activity, eating, ruminating or other activities (Beauchemin *et al*. 1989). Eating typically occurs with a high number of jaw movements, either to get food into the mouth or to chew it. The number of movements per second can be as high as 5 or 6. In addition, the idle pauses within a meal because of satiation, rest, or simply distraction, do not show regular patterns. However, when ruminating, a slow and careful chewing appears, at a fairly constant rate rarely higher than 2 chews per second. The ruminating chews are grouped into activity cycles lasting roughly 1 min, corresponding to the rumination cycles. The pause between consecutive cycles lasts 6–12 s.

The system was tested indoors by feeding lucerne hay to the animals in individual crates equipped with a semi-automatic food intake recording system (Amor *et al*. 1994). The measurements for the intervals where the chewing activity was due to food intake were positively correlated with the size of the meals detected by the food intake recording system, as shown in the Figure. From the resulting equations, and given the series of chewing activities stored, the size of the corresponding meals can be estimated.



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Melatonin changes the pattern of daily food intake in streptozotocin-induced diabetic rats. By V. MOLPECERES, M.V. GARCÍA-MEDIAVILLA and J.P. BARRIO, *Departamento de Fisiología, Universidad de León, 24071 León, Spain*

Melatonin has been suggested to have protective effects on metabolism in diabetic animals (Sailaja Devi *et al.* 2000; Vural *et al.* 2001), but its influence on voluntary food intake has not been extensively studied. Preliminary work is reported here involving six male rats (219 (SD 5) g body weight), which were kept in the animal house under a controlled light and temperature environment (12 h daylight/12 h dark, 20 (SD 2) °C), individually placed in metabolic cages and fed standard rat chow and water *ad libitum*. Experimental diabetes was induced after 7 d acclimation using streptozotocin (60 mg/kg). After 3 d all animals showed glycemia levels were higher than 300 mg/100 ml. Continuous food intake monitoring was performed through computer reading of electronic scales. Three animals (group DM) were administered melatonin in the drinking water (1 mg/kg) during the nocturnal phase of each day for 7 weeks. The remaining animals (group D) were given plain tap-water to drink. Standard feeding behaviour parameters were calculated considering a minimum inter-meal interval of 5 min, a minimum meal duration of 1 min, and a minimum meal size of 0.1 g. Separate analysis was made for the diurnal and nocturnal components of the daily feeding patterns obtained. Daily food intake was not changed by melatonin (D: 27.89 (SE 0.75), DM: 29.59 (SE 0.78) g/24 h). Time spent eating during the day was also not significantly different (D: 335.46 (SE 10.02), DM: 336.96 (SE 9.12) min/24 h), nor was the number of meals per day (D: 18.50 (SE 0.48), DM: 18.01 (SE 0.58)). However, melatonin treatment induced significant changes in most parameters when the photoperiod was taken into account, as shown in the Table.

	NDM		NNM		TSDM (g)		TSNM (g)		TDDM (min)		TDNM (min)		ASDM (g)		ASNM (g)	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
D	6.8	0.3	11.7	0.4	10.9	0.5	16.9	0.5	142.8	7.1	192.7	6.4	1.7	0.1	1.6	0.1
DM	5.7	0.2†	12.4	0.5	9.2	0.4*	20.3	0.7†	117.7	6.9†	238.2	6.9†	1.8	0.1	2.1	0.1†

Significantly different from D group: **P*<0.05, †*P*<0.001.

Number of daylight meals (NDM), total size of daylight meals (TSDM) and total duration of daylight meals (TDDM) were lower in the animals receiving melatonin during the dark photophase. Conversely, total size of nocturnal meals (TSNM), total duration of nocturnal meals (TDNM) and average size of nocturnal meals (ASNM) were lower in animals not receiving melatonin. Total daily water intake was also significantly higher in melatonin-treated animals (D: 164.0 (SE 6.2), DM: 202.4 (SE 7.8) ml/d, *P*<0.001). While supporting data needs to be accomplished, daily food intake rearrangement can be expected when including melatonin supplementation in the diet.

Sailaja Devi MM, Suresli Y & Das UN (2000) *Journal of Pineal Research* **2**, 108–115.
Vural H, Sabuncu T, Arslan SO & Aksoy N (2001) *Journal of Pineal Research* **31**, 193–198.

Factors influencing the perception of amount in servings of chips with different thicknesses. By S.E. COVINGTON and A. WISE, *The Robert Gordon University, Queen's Road, Aberdeen AB15 4PH*

Calvin & Wise (2001) showed that when people are asked to serve themselves a portion of chips, mean weights adjusted for sex were 187.1, 156.9 and 108.5 g for thick, medium, and thin chips, respectively. Each of these values was significantly different from each other depending on the thickness of the chips ($P<0.001$). Some of the difference in portion weight might relate to the visual perception of the chips on the plate or to handling effects caused by the method of serving chips of different thicknesses. In the present study to investigate this phenomenon further, two types of McCain oven-chip were used: Home Fries (13.5 g/chip) and Stringfellows (3.1 g/chip). They were oven-baked at 240º for 25 and 22 min, respectively. In order to test whether contrast between chip colour and plate background colour might influence portion weight, half of the plates (25 cm diameter) were painted yellow. In order to test whether type of serving utensil would influence portion weight, both tongs and a fish-slice were used. Subjects were recruited randomly from the students seated in the refectory and invited singly to enter the experimental kitchen. They were provided with two bowls of chips, one of each type, both serving implements and eight plates, four of each colour. They were asked to put a portion of chips onto each plate, assuming that the dish consisted only of chips and that they should make each portion approximately the same size. As each portion of chips was served, the number of times the utensils were used was counted, and when the subject had left the room the height and weight of chips on each plate were recorded. In order to eliminate bias, the order of the eight different combinations of serving type were arranged in a Latin square, repeated eight times using sixty-four subjects (twenty-one male and forty-three female). Results were subjected to four-way ANOVA: colour × implement × thickness × person. As expected, the weight for thin chips was significantly lower than for thick ones (141.2 *v.* 235.0 g; $P<0.001$), but mean weights were higher than in the previous study. No significant effects of plate colour or serving utensil were found. However, there was a small significant ($P=0.033$) interaction between plate colour and thickness. The mean weight of thin chips on a white plate was 138.3 g and on a yellow plate 144.0 g, but for thick chips weights were 235.9 g and 234.2 g. The distribution of number of dips of the utensils was significantly less ($P<0.001$ by χ^2 test) for thin (mean number 4.02) than thick chips (4.67). The height of thin chips on the plates was only slightly less (60.5 *v.* 64.8 mm), but this was significant ($P<0.001$) by four-way ANOVA.

The results suggest that subjects may judge the amount of chips per plate in relation to the height achieved, since the data values for thick chips were only 7% greater, whilst the weight differed by 66%. For thin chips, subjects might judge when to stop loading the plate by using the contrast between the coloured chips and a white plate and tended to overload the plate when the contrast was reduced. There was a tendency to make more dips of the utensil into the bowl when thick chips were involved. Many questions remain concerning our perceptions of foods during serving, for example what is the influence of current hunger or satiety, whether subjects are required to consume the food or not, and possible social influences. In this study it is interesting to note that the presence of a male experimenter was associated with higher portion weights than in the previous study, in which the experimenter was female.

Calvin J & Wise A (2001) *Annals of Nutrition and Metabolism* **45** (Suppl. 1), 368–369.

Approaches to weight maintenance in a work-site setting. By W.S. LESLIE, M.E.J. LEAN and C.R. HANKEY, *University of Glasgow Department of Human Nutrition, Queen Elizabeth Building, Glasgow Royal Infirmary, Glasgow G31 2ER*

Maintaining weight loss has been recognized by health professionals and patients as the most difficult part of weight management. The importance of weight maintenance has been emphasized in a current clinical guideline for weight management (SIGN, 1996), but no guidance was given as to how this is best achieved. At present, weight maintenance strategies are poorly defined, although improved effectiveness is seen with continued therapist contact (Perri *et al*. 1993), which is labour-intensive and expensive. The present study tested the effectiveness of two forms of dietary advice for weight maintenance and the effectiveness of electronic mail (e-mail) as a monitoring tool within a low-intensity weight maintenance programme.

A randomized controlled weight-management study was carried out at a large industrial work-site. The 24-week programme comprised 12 weeks weight loss followed by a 12-week weight maintenance period. Males with a BMI >25 kg/m^2 were recruited and allocated to one of two dietary approaches: either an individualized energy deficit (ED) diet (estimated BMR × a physical activity level of 1.3 – 2510 kJ) (Lean & James, 1986) or a 6276 kJ generalized low-energy (GLE) diet. The males recruited to the study were employed in a variety of duties ranging from sedentary office tasks to manual work. Ninety-one males (mean BMI 30.8 (SD 3.6), mean age 42 (SD 7) years) completed the weight loss period, and achieved a mean weight loss of –4.6 (SD 3.5) kg ($P<0.001$). No difference in weight loss was evident between the two dietary approaches ($P=0.35$). For the weight maintenance period, general healthy eating principles were reviewed with participants in the GLE group, whereas in the ED group individualized energy prescriptions were recalculated using an estimated BMR × a physical activity level of 1.4. To enhance weight maintenance, follow-up contacts were made at 2-weekly intervals by e-mail.

Eighty-five males completed the weight maintenance period. Six participants chose to withdraw from the study, four failed to respond to e-mails, one was unwell and one ceased employment. Mean weight gain was +1.1 (SD 1.8) kg ($P<0.001$), with no differences between the groups (ED +0.9 (SD 2.0) kg and GLE +1.4 (SD 1.6) kg ($P=0.27$)). No difference between groups was seen in the number of males changing weight ($P=0.20$). The 62 males who gained weight and the 21 who lost weight had mean weight changes of +1.9 (SD 1.3) and –1.1 (SD 1.0) kg respectively.

Maintenance period	All males (*n* 85)	Energy Deficit group (*n* 38)	Generalized Low Energy group (*n* 47)
Weight stable	2	0	2
Weight loss	21	9	12
Weight gain	62	29	33

The finding that close to 25% of mean weight loss had been regained, by these overweight males, after only 12 weeks confirms that weight maintenance is difficult to achieve. The two contrasting dietary approaches – one prescriptive, one general – made no difference to the success of maintenance. For those who gained weight, an unwillingness to restrain or alter their eating patterns permanently is compatible with their swift weight regain.

Electronic mail was a useful, convenient and flexible tool for use in a weight management programme. However, as the e-mail contacts were made at the subject's place of work, they may have been assigned a lower priority than other work-related contacts. This may also reflect the priority assigned by the participants to complying with the advice offered during weight maintenance.

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Perri MG, Sears SF & Clark JE (1993) *Diabetes Care* **16**, 393–415.
SIGN (1996) *Guidelines 8.* Edinburgh: Scottish Intercollegiate Guidelines Network.

Estimating dietary flavonoid intake: comparison of a semi-quantitative food frequency questionnaire with 4-day weighed diet records in a Scottish population. By J. KYLE[1], L.F. MASSON[2], D.A. GRUBB[1], G.G. DUTHIE[1] and G. McNEILL[2], [1]*Rowett Research Institute, Bucksburn, Aberdeen AB21 9SB and* [2]*Faculty of Medicine and Medical Sciences, University of Aberdeen, Foresterhill, Aberdeen AB25 2ZD*

Dietary flavonoids are naturally occurring plant compounds distributed widely in the human diet, with major sources including tea, red wine, fruits and vegetables. More than 4000 different flavonoids have been identified and subsequently divided into thirteen flavonoid subclasses. Recently a flavonoid database (unpublished results) has been developed to estimate dietary intake of fourteen selected compounds representing five flavonoid subclasses: flavonols, flavones, proanthocyanidins, catechins and flavanones. We used this database to derive and compare estimates of intake from the Scottish Collaborative Group 150-item semi-quantitative food frequency questionnaire (FFQ) version 6.31 and 4 d weighed records (WR). Healthy residents of Aberdeen were recruited, comprising forty-one men, mean age 36 (range 21–56) years, and forty women, mean age 33 (range 19–58) years. All participants kept a 4 d WR covering three weekdays and one weekend day, either before or after completing a FFQ. There was a wide range of intakes for all subclasses by both methods but there was no significant difference in intake between men and women. Estimated intakes were energy-adjusted and Spearman rank correlation coefficients between the WR and FFQ were calculated. Flavone and flavanone intakes were skewed, and thus were log-transformed before energy adjustment. Subjects were then grouped into thirds of intake and percentages of subjects in the same and opposite third were calculated.

Flavonoid subclass	Daily intake Median (range)[†]		Correlation coefficient	Classification into thirds	
	WR (*n*=81)	FFQ (*n*=81)	(*n*=81)	% same 3rd	% opposite 3rd
Flavonols (Quercetin + Kaempferol + Myricetin)	18.8 (1.9–51.3)	27.0 (1.1–136.7)	0.703**	64	4
Flavones (Apigenin + Luteolin)	0.1 (0–6.7)	0.7 (0.1–2.9)	0.117	26	12
Proanthocyanidins (Procyanidin B1 + B2 + B3 + B4)	22.5 (0–144.5)	31.9 (1.2–190.4)	0.726**	64	4
Catechins (C + EC + EGC + ECG + EGCG + GC)[‡]	59.0 (1.8–263.3)	59.0 (1.8–263.3)	0.941**	85	0
Flavanones (Hesperidin + Narigenin)	1.2 (0–238.6)	17.5 (0–248.1)	0.331*	43	19

[†] mg/day, [‡] C – catechin, EC – epicatechin, EGC – epicatechingallate, EGCG – epigallocatechingallate, GC – gallocatechin.
**P<0.001, *P<0.05.

Foods potentially containing the flavonoids of interest consumed during 4 d WR collection had previously been reviewed during database development. Good agreement in ranking between WR and FFQ, with correlation coefficients >0.70 (P>0.001) for flavonols, procyanidins and catechins, were observed. However, correlation coefficients for flavones and flavanones were low, with poor agreement in the classification into thirds. Dietary sources of both classes of flavonoid are limited, with flavones found in celery and fresh herbs, and flavanones in citrus fruits. The poor results may reflect the short exposure time of WR, unlike the 3 months retrospectively considered by the FFQ; for example, thirty-eight participants consumed no flavones during WR collection compared with one individual identified by the FFQ. Overall, these results indicate that the FFQ can adequately rank individual intakes of flavonols, procyanidins and catechins, but not of flavones or flavanones. Tea as the main source of flavonoids was equally represented by both methods of assessment.

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