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Glycaemic index and glycaemic load values of commercially available products in the UK

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The objective of this paper is to provide glycaemic index (GI) and glycaemic load (GL) values for a variety of foods that are commercially available in the UK and to compare these with previously published values. Fasted subjects were given isoglucidic (50 or 25 g carbohydrate) servings of a glucose reference at least two to three times, and test foods once, on separate occasions. For each test food, tests were repeated in at least eight subjects. Capillary blood glucose was measured via finger-prick samples in fasting subjects (0 min) and at 15, 30, 45, 60, 90 and 120 min after the consumption of each test food. The GI of each test food was calculated geometrically by expressing the incremental area under the blood glucose response curve (IAUC) of each test food as a percentage of each subject's average IAUC for the reference food. GL was calculated as the product of the test food's GI and the amount of available carbohydrate in a reference serving size. The majority of GI values of foods tested in the current study compare well with previously published values. More importantly, our data set provides GI values of several foods previously untested and presents values for foods produced commercially in the UK.

Glycaemic index: Glycaemic load

The glycaemic index (GI), first introduced in 1981 (Jenkins *et al.* 1981), is a classification of the blood glucose-raising potential of carbohydrate foods. It is defined as the incremental area under the blood glucose curve (IAUC) of a 50 g carbohydrate portion of a test food expressed as a percentage of the response to 50 g carbohydrate of a reference food taken by the same subject, on a different day (Food and Agriculture Organization/World Health Organization, 1998).

Since the concept of GI was first introduced, many studies have investigated the potential health benefits of low-GI foods. The GI of foods may have important implications for the prevention and treatment of the major causes of morbidity and mortality in Western countries, including type 2 diabetes, CHD and obesity. Today, there is an important body of evidence to support the therapeutic potential of low-GI diets, not only in diabetes (Björck *et al.* 1994; Frost *et al.* 1994; Gilbertson *et al.* 2001), but also in subjects with hyperlipidaemia (Jenkins *et al.* 1987*a*). In addition, low-GI foods have been associated with prolonged endurance during physical activity (Thomas *et al.* 1991), improved insulin sensitivity (Frost *et al.* 1998), increased colonic fermentation (Jenkins *et al.* 1987*b*; Wolever *et al.* 1992) and appetite regulation (Warren *et al.* 2003). More recent data support the preventive potential of a low-GI diet against the development of type 2 diabetes and CVD (Salmeron *et al.* 1997*a*,*b*; Frost *et al.* 1999; Meyer *et al.* 2000).

The use of GI for the classification of carbohydrate-rich foods has been endorsed by the FAO/WHO, who recommended that the GI of foods be considered together with information about food composition to guide food choices (Food and Agriculture Organization/World Health Organization, 1998). GI values represent the glycaemic response of isoglucidic foods, and therefore are not always representative of the glycaemic effect of a typical serving of that food. To quantify the overall glycaemic effect of a standard portion of food, the concept of glycaemic load (GL) was introduced (Salmeron *et al.* 1997*a*,*b*). The GL of a typical serving of food is the product of the amount of available carbohydrate in that serving and the GI of the food, divided by 100. It is often necessary to consider the GL alongside GI values, especially when the carbohydrate content of the food is relatively small. For example, broad beans have been shown to have a high GI but because they contain very little carbohydrate they have a low GL (Foster-Powell *et al.* 2002).

The GI of foods varies significantly due to factors such as particle size, cooking and food processing, other food components (e.g. fat, protein, dietary fibre) and starch structure (Björck *et al.* 1994). Consequently, there is often considerable variation in the GI of the same food produced in different countries or by different manufacturers.

Publication of reliably measured GI and GL values is needed to prevent unnecessary repetition of work and improve work in this exciting area. The largest table of GI and GL values published to date lists 750 different items across a range of globally produced

Abbreviations: GI, glycaemic index; GL, glycaemic load; IAUC, incremental area under the blood glucose response curve.

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food groups and brands (Foster-Powell *et al.* 2002). The table represents a valuable and well-cited resource for researchers and clinicians and is likely to have been instrumental in sparking the explosion of research in this area. However, the vast majority of published GI values are Australasian or Canadian in origin, with some Danish, French and Swedish values. There is currently a paucity of published GI values for foods produced in the UK. The aim of the current work is to provide reliable values of GI and GL for a range of foods commercially available in the UK. This initiative was the outcome of the Tesco Stores Limited GI labelling programme introduced in June 2004.

Methods

Subjects

A total of 189 (seventy male, 119 female) healthy subjects were recruited to take part in the study. Subjects were recruited through posters distributed at Oxford Brookes University (*n* 112) and the University of Reading (*n* 77). Exclusion criteria were as follows: age <18 or >55 years; BMI ≥ 25 kg/m^2; fasting blood glucose value $>6{\cdot}1$ mmol/l. Ethical approval for the study was obtained from the respective university's Research Ethics Committee. Subjects were given full details of the study protocol and the opportunity to ask questions. All subjects gave written informed consent prior to participation.

All anthropometric measurements were made in the fasting state. Height was recorded to the nearest centimetre using a stadiometer (Seca Ltd, Birmingham, UK), with subjects standing erect and without shoes. Body weight was recorded to the nearest 0·1 kg using the Tanita BC-418 MA (Tanita UK Ltd, Yiewsley, Middx, UK), with subjects wearing light clothing and no shoes. BMI was calculated using the standard formula: weight (kg)/height (m)^2. Characteristics of the subjects are shown in Table 1.

Study protocol

The protocol used was adapted from that described by Wolever *et al.* (1991) and is in line with procedures recommended by the Food and Agriculture Organization/World Health Organization (1998). For each test food, tests were repeated in a minimum of eight subjects. Subjects tested between two and twelve test foods. On the day prior to a test, subjects were asked to restrict their intake of alcohol and caffeine-containing drinks and to restrict their participation in intense physical activity (e.g. long periods at the gym, excessive swimming, running, aerobics). Subjects were also told not to eat or drink after 21.00 hours the night before a test, although water was allowed in moderation.

Test foods

A number of different foods were tested, including breads, cereals, pasta, basmati rice varieties, pulses, ready-to-eat meals and low-fat yoghurts. These foods represent a diverse range of commercial foods commonly consumed in the UK. All foods were provided by Tesco Stores Limited and were originally tested for GI labelling purposes. All foods were tested in equivalent available carbohydrate amounts (50 or 25 g) and compared with a reference food (glucose). Available carbohydrate values were provided by the manufacturer. Most foods were tested against 50 g available carbohydrate; however, if the serving size was considered too large to consume comfortably, foods were tested against 25 g available carbohydrate (Brouns *et al.* 2005).

Table 1. Characteristics of study population

(Mean values and standard deviations for 189 subjects)

	Mean	SD
Age (years)	36·5	11·8
Height (m)	1·70	0·10
Weight (kg)	68·3	14·3
BMI (kg/m^2)	23·4	4·3

Where required, foods were prepared following the manufacturer's instructions. All breakfast cereals were consumed dry with the exception of the porridge products, which were made with water and cooked in the microwave according to the manufacturer's instructions. Unsalted water was used when soaking or boiling foods was necessary.

In accordance with FAO/WHO recommendations, subjects tested each test food once and the reference food two or three times in random order on separate days, with at least a 1 d gap between measurements to minimise carry-over effects (Food and Agriculture Organization/World Health Organization, 1998). Subjects were studied in the morning after a 12 h overnight fast. Subjects consumed the reference/test food at a comfortable pace, within 15 min. The test foods and reference food were served with 200 ml water. A further 200 ml water was given during the subsequent 2 h. Subjects were encouraged to keep physical activity to a minimum during the testing.

Blood glucose measurements

A qualified technician performed blood glucose measurements. A fasting blood sample was taken at 0 min and the reference/test food was consumed immediately after this. Further blood samples were taken at 15, 30, 45, 60, 90 and 120 min after starting to eat.

Blood was obtained by finger-prick using the Glucolet 2 multipatient lancing system (Bayer HealthCare, Newbury, Berks., UK). Recent reports suggest that capillary rather than venous blood sampling is preferred for reliable GI testing (Food and Agriculture Organization/World Health Organization, 1998; Wolever, 2003; Brouns *et al.* 2005). Prior to a finger-prick, subjects were encouraged to warm their hand to increase blood flow. Fingers were not squeezed to extract blood from the fingertip in order to minimise plasma dilution. Blood glucose was measured using Ascensia Contour® automatic blood glucose meters (Bayer HealthCare). The blood glucose meters were calibrated daily using control solutions from the manufacturer and were also regularly calibrated against a clinical dry chemistry analyser (Reflotron® Plus; Roche, Welwyn Garden City, Herts., UK) and the HemoCue Glucose 201+ analyser (HemoCue® Ltd., Dronfield, Derbyshire, UK).

Fig. 1 shows the Pearson regression and Bland–Altman analyses for a random selection of 140 blood samples simultaneously measured using the Ascensia Contour® and the HemoCue Glucose 201+ analyser. There was a very strong correlation (r 0·980, $P<0{\cdot}001$) and good agreement (mean difference $-0{\cdot}2$ mmol; 95 % CI $-0{\cdot}3$, $-0{\cdot}2$; limits of agreement $-0{\cdot}80$, 0·32) between blood glucose measurements using the automatic analyser and the HemoCue analyser.

Calculation of glycaemic index and glycaemic load

The IAUC, ignoring the area beneath the baseline, was calculated geometrically for each food (Food and Agriculture Organization/

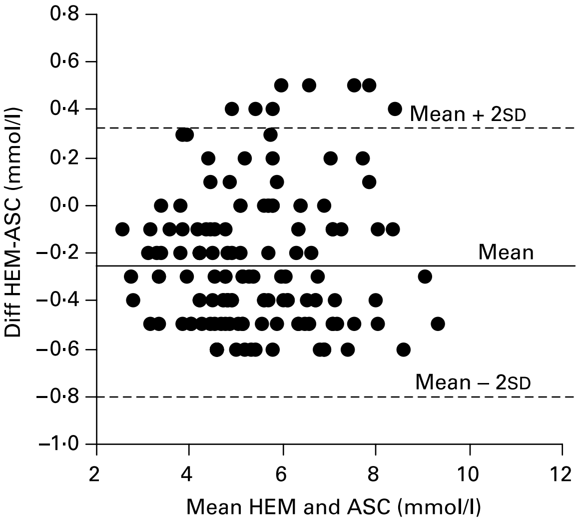

Fig. 1. Bland–Altman analyses of blood glucose measurements between the Ascensia Contour® (ASC) and HemoCue 201+ analyser (HEM). For details of subjects and procedures, see p. 923.

World Health Organization, 1998). The mean, standard deviation and CV of the IAUC of each subject's repeated reference food were calculated. The IAUC for each test food eaten by each subject was expressed as a percentage of the mean IAUC for the reference food eaten by the same subject: GI = (IAUC test food/IAUC reference food) × 100. The GI of each test food was taken as the mean for the whole group.

The GL of a specific serving of each food was calculated using the following equation: GL = (GI of test food × available carbohydrate in a serving of test food [g])/100.

Serving size of each test food was taken from manufacturers' information or where this was not available from a well-recognised book of standard food portion sizes (Ministry of Agriculture, Fisheries and Food, 1993).

Statistical analysis

Statistical analysis was performed using the Statistical Product and Service Solutions software (SPSS version 11.0.1; Chicago, IL, USA). To examine the correlation and agreement between the automatic analyser and the HemoCue Glucose 201+ analyser, the Pearson's correlation coefficient and the method of Bland and Altman (1986) were used. Levels of inter- and intra-individual variation of the three standard (glucose) tests were assessed by determining the CV%. Spearman's correlation coefficient, ρ, was used to assess the relationship between GI values and nutrient content of the test foods. Statistical significance was set at $P<0{\cdot}05$.

Results

The mean CV of glycaemic responses to the three standard tests for the 189 subjects was 26 %. The inter-individual CV in glycaemic response to the 25 and 50 g standard tests was 42 % and 38 %, respectively. These values are consistent with previously reported data (Wolever, 1990).

The GI and GL values for all tested foods are given in Table 1. Values are given as means with their standard errors. For practical application, GI values are often grouped into categories as producing a low, medium or high glycaemic response: low ≤55; medium 56–69 inclusive; high ≥70 (Brand-Miller *et al.* 2003). Both the bread and cereals produced a wide range of GI values with some producing low (e.g. malted wheat bread, bran flakes), some medium (e.g. white pitta bread, Value muesli) and some high (e.g. Value fruit loaf, sultana bran). All pasta products fell into the low-GI category, while the basmati rice was low to medium. All dried pulses and dairy products had low GI values, as did the majority of ready-to-eat meals and dried fruits and nuts tested.

There was no strong relationship between GI value and macronutrient content per 100 g of the test foods (Fig. 2): energy intake (Spearman's ρ 0·447; $P<0{\cdot}001$); percentage of energy from protein (Spearman's ρ −0·441; $P<0{\cdot}001$); percentage of energy from fat (Spearman's ρ −0·005; $P=0{\cdot}960$).

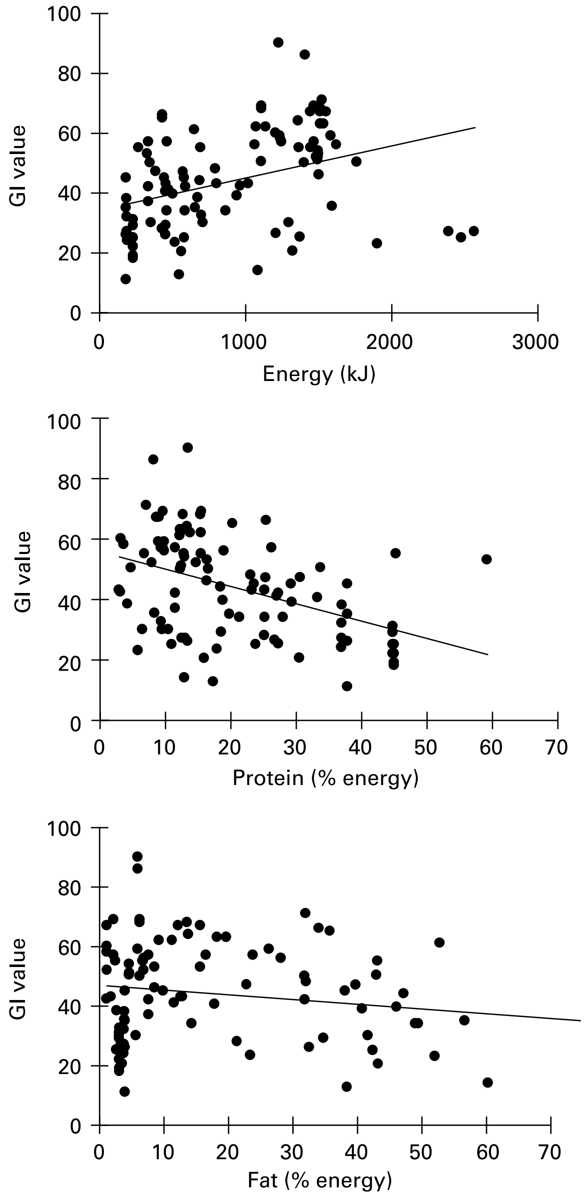

Fig. 2. Relationship between glycaemic index (GI) values and energy, protein and fat content per 100 g test food. For details of subjects and procedures, see p. 923.

Table 2. Table of glycaemic index (GI) and glycaemic load (GL) values for UK foods*

Food		Carbohydrate (g/100 g)	Experimental portion (g)	GI		Standard serving size (g)	Carbohydrate (g per serving)	GL (per serving)	Subjects (*n*)
				Mean	SEM				
Breads									
1	Crusty malted wheat bread (Finest)	44·2	113·1	52	8	30	13·3	7	10
2	Multi-grain batch bread	47·7	104·8	62	8	50	23·9	15	10
3	Oatmeal batch bread	50·1	99·8	62	8	50	25·1	16	10
4	Malt loaf, organic	61·2	81·7	59	9	35	21·4	13	10
	Fruit bread								
5	Fruit and cinnamon bread (Finest)	52·7	94·9	71	11	37	19·5	14	10
6	Fruit loaf, sliced	54·4	91·9	57	6	30	16·3	9	10
7	Fruit loaf (Value)	59·5	84·0	90	11	30	17·9	16	10
	Pitta bread								
8	Pitta, white, mini	51·2	97·7	68	5	30	15·4	10	10
9	Pitta, white (Value)	51·2	97·7	69	20	60	30·7	21	10
10	Pitta, wholemeal	46·4	107·8	56	13	60	27·8	16	10
Breakfast cereals									
11	Fruit and fibre	69·1	72·4	67	7	30	20·7	14	10
12	Fruit and fibre (Value)	65·7	76·1	68	7	40	26·3	18	8
	Muesli								
13	Muesli, fruit and nut	60·3	82·9	59	11	50	30·2	18	8
14	Muesli, fruit	67·2	74·4	67	7	50	33·6	23	10
15	Muesli (Healthy Eating)	71·1	70·3	86	10	50	35·6	31	10
16	Muesli (Value)	62·6	79·9	64	9	50	31·3	20	10
17	Muesli, wholewheat	59·1	84·6	56	6	50	29·6	17	10
	Bran-cereal								
18	Hi fibre bran	38·5	129·9	43	10	30	11·6	5	10
19	Branflakes (Healthy Living)	67·1	74·5	50	7	30	20·1	10	10
20	Sultana bran (Healthy Living)	58·1	86·1	90	17	30	17·4	16	10
	Porridge†								
21	Porridge oats, organic	57·8	86·5	63	11	50	28·9	18	8
22	Porridge oats, Scottish	62·0	80·6	63	7	50	31·0	20	10
23	Porridge oats (Value)	60·4	82·8	63	15	50	30·2	19	8
Dry pastas‡									
24	Lasagne, egg	66·2	75·5	53	9	50	33·1	18	10
25	Lasagne, egg, verdi	69·1	72·4	52	6	50	34·6	18	8
26	Lasagne sheets (Value)	72·0	69·4	55	8	50	36·0	20	8
27	Fusilli pasta twists	72·6	68·9	54	11	50	36·3	20	10
28	Fusilli pasta twists, wholewheat	62·5	80·0	55	8	50	31·3	17	10
29	Fusilli pasta twists, tricolour	68·5	73·0	51	11	50	34·3	17	8
30	Tagliatelle, egg	66·4	75·3	46	6	50	33·2	15	8
Basmati rice									
31	Basmati rice, Indian, boiled 8 min	76·1	65·7	69	6	75	57·1	39	8
32	Basmati rice, Indian, easy-cook, boiled 9 min	79·8	62·7	67	11	75	59·9	40	8
33	Basmati rice (Value), boiled 12 min	79·4	63·0	52	11	50	39·7	21	8
34	Basmati rice, organic, boiled 10 min	76·1	65·7	57	10	75	57·1	33	8
Dried pulses									
35	Butter beans, soaked overnight, boiled 50 min	49·8	100·4	26	7	150	74·7	19	8
36	Pearl barley, boiled 60 min	82·2	60·8	35	4	150	123·3	43	8
37	Red kidney beans, soaked overnight, boiled 60 min	40·2	124·4	51	5	150	60·3	31	8
38	Lentils, red, split, boiled 25 min	51·3	97·5	21	7	150	77·0	16	8
39	Peas, yellow, split, dried, soaked overnight, boiled 55 min	56·6	88·3	25	6	150	84·9	21	8

Table 2. *Continued*

	Food	Carbohydrate (g/100 g)	Experimental portion (g)	GI		Standard serving size (g)	Carbohydrate (g per serving)	GL (per serving)	Subjects (n)
				Mean	SEM				
Ready-to-eat meals									
40	Lasagne, beef (frozen)	11·8	423·7	47	7	400	47·2	22	10
41	Lasagne, meat (Healthy Living, chilled)	12·7	393·7	28	4	340	43·2	12	8
42	Lasagne	10·1	495·0	25	5	400	40·4	10	8
43	Lasagne (Finest)	10·2	490·2	34	8	300	30·6	10	10
44	Lasagne, vegetarian	13·6	367·6	20	6	430	68·8	14	8
45	Cannelloni, spinach and ricotta	17·9	279·3	15	4	400	71·6	11	8
46	Pasta bake, tomato and mozzarella	14·2	352·1	23	4	340	48·3	11	8
47	Fajitas, chicken	14·2	352·1	42	14	275	38·9	17	8
48	Chow mein, chicken (Serves One)	12·2	409·8	47	7	475	60·0	28	8
49	Chow mein, chicken (Healthy Living)§	7·6	394·7	55	7	450	34·2	19	8
50	Sweet and sour chicken with noodles (Serves One)	17·2	290·7	41	7	475	81·7	33	8
51	Chilli beef noodles (Finest)	15·2	328·9	42	4	450	68·4	29	8
52	Cumberland fish pie	10·4	480·8	40	5	250	26·0	10	8
53	Cumberland pie	12·4	403·2	29	6	500	62·0	18	8
54	Cottage pie	11·2	446·4	65	8	500	56·0	36	10
55	Shepherds pie	14·7	340·1	66	9	500	73·5	49	10
56	Sausage and mash	13·4	373·1	61	7	500	67·0	41	10
57	Beef and ale casserole (Finest)§	6·8	441·2	53	12	300	14·9	8	8
58	Steak and ale with cheddar mash (Finest)§	8·6	348·8	48	12	550	47·3	23	8
59	Mushroom stroganoff with rice	14·4	347·2	26	6	400	57·6	15	8
60	Lamb moussaka (Finest)§	9·1	329·6	35	8	330	30·0	11	10
61	Tandoori chicken masala and rice (Finest)	17·4	287·4	45	5	550	111·7	50	10
62	Chicken tikka masala/rice (Healthy Living)	20·1	248·8	34	7	550	110·6	38	8
63	Chicken korma/rice (Healthy Living)	15·9	314·5	45	9	450	71·6	32	8
64	Chicken korma and peshwari rice (Finest)	15·9	314·5	44	6	550	87·5	39	8
Dairy products									
	Milk								
65	Milk, skimmed, pasteurised, British (Dairycrest)‖	5·0	500	48	15	250	12·5	6	10
66	Milk, semi-skimmed, pasteurised, British (Dairycrest)‖	5·0	500	25	6	250	12·5	3	8
67	Milk, semi-skimmed, pasteurised, organic (Arla)‖	5·0	500	34	8	250	12·5	4	9
68	Milk, standardised homogenised, pasteurised, British (Dairycrest)‖	4·7	531·9	46	10	250	11·8	5	10
69	Milk, whole, pasteurised, fresh, organic (Arla)‖	4·8	520·8	34	6	250	12·0	4	9
	Yoghurt								
70	Yoghurt, peach melba (Value)§	16·0	187·5	57	5	125	20·0	11	8
71	Yogurt, low fat, peach melba (Value)‖	14·0	357·1	56	11	125	17·5	10	10
72	Yoghurt, low fat, strawberry (Value)‖	14·2	352·1	85	19	125	17·8	15	10
73	Yoghurt, low fat, apricot‖	14·1	354·6	42	6	150	21·1	9	10
74	Yoghurt, low fat, black cherry‖	14·3	349·7	41	5	150	21·5	9	10
75	Yoghurt, low fat, hazelnut‖	14·0	357·1	53	9	150	21·0	11	10
76	Yoghurt, low fat, raspberry‖	14·9	335·6	34	6	150	22·4	8	10
77	Yoghurt, low fat, strawberry‖	14·4	347·2	62	11	150	21·6	13	10
78	Yoghurt, low fat, toffee‖	17·4	287·4	51	18	150	26·1	13	10
79	Yoghurt, low fat, natural‖	5·8	431	35	10	200	11·6	4	9
80	Yoghurt, black cherry (Healthy Living Light)‖	8·7	287·4	67	15	200	17·4	12	10
81	Yoghurt, peach and apricot (Healthy Living Light)‖	8·1	308·6	28	6	200	16·2	5	9
82	Yoghurt, raspberry (Healthy Living Light)‖	8·1	308·6	43	8	200	16·2	7	10
83	Yoghurt, strawberry (Healthy Living Light)‖	7·9	316·5	30	6	200	15·8	5	10
84	Yoghurt, toffee (Healthy Living Light)‖	7·5	333·3	41	11	200	15·0	6	10
85	Yoghurt, vanilla (Healthy Living Light)‖	7·0	357·1	47	13	200	14·0	7	10

Table 2. *Continued*

	Food	Carbohydrate (g/100 g)	Experimental portion (g)	GI Mean	GI SEM	Standard serving size (g)	Carbohydrate (g per serving)	GL (per serving)	Subjects (*n*)
86	Yoghurt, black cherry (Finest)‖	16	312·5	17	3	150	24·0	4	10
87	Yoghurt, bourbon vanilla (Finest)‖	19·2	260·4	64	14	150	28·8	18	10
88	Yoghurt, champagne rhubarb (Finest)‖	16·8	297·6	49	12	150	25·2	12	10
89	Yoghurt, Devonshire fudge (Finest)‖	22·4	223·2	37	7	150	33·6	12	10
90	Yoghurt, lemon curd (Finest)‖	20·1	248·8	67	14	150	30·2	20	10
91	Yoghurt, orange blossom (Finest)‖	20·1	248·8	42	11	150	30·2	13	10
92	Yoghurt, Scottish raspberry (Finest)‖	18·9	264·6	32	7	150	28·4	9	10
93	Yoghurt, strawberry and cream (Finest)‖	15·4	324·7	41	6	150	23·1	8	10
94	Yoghurt, Valencia orange (Finest)‖	16·6	301·2	34	7	150	24·9	13	10
95	Yoghurt, white peach (Finest)‖	16·1	310·6	54	21	150	24·2	13	10
96	Yoghurt, Greek style, honey topped‖	13·6	367·6	36	7	140	19·0	7	9
	Yoghurt, red fruit (Health Living Light)								
97	Raspberry and cranberry§	6·3	476·2	42	12	125	7·9	3	9
98	Raspberry and black cherry§	6·1	491·8	37	8	125	7·6	3	9
99	Strawberry§	6·0	500·0	45	16	125	7·5	3	9
100	Morello cherry§	6·6	454·5	35	6	125	8·3	3	9
	Yoghurt, summer fruit (Health Living Light)								
101	Peach and vanilla§	6·3	476·2	26	7	125	7·9	2	9
102	Apricot§	6·3	476·2	11	4	125	7·9	1	9
103	Strawberry§	6·0	500·0	36	9	125	7·5	3	9
104	Raspberry§	6·0	501·0	28	5	125	7·5	2	9
	Yoghurt, tropical fruit (Health Living Light)								
105	Guava and passionfruit§	6·7	447·8	24	7	125	8·4	2	9
106	Pineapple§	6·5	461·5	38	7	125	8·1	3	9
107	Mango§	6·6	454·5	32	8	125	8·3	3	9
108	Peach and apricot§	6·4	468·8	27	6	125	8·0	2	9
	Fromage frais								
	Fromage frais, red fruit (Healthy Living)								
109	Red cherry§	7·2	416·7	25	6	100	7·2	2	10
110	Raspberry§	6·8	441·2	31	8	100	6·8	2	10
111	Blackcurrant§	7·2	416·7	22	5	100	7·2	2	10
112	Strawberry§	6·6	454·5	29	9	100	6·6	2	9
	Fromage frais, yellow fruit (Healthy Living)								
113	Pineapple and passionfruit§	7·1	422·5	18	5	100	7·1	1	8
114	Mango and papaya§	7·0	428·6	25	7	100	7·0	2	8
115	Mandarin and orange§	7·0	428·6	19	6	100	7·0	1	9
116	Peach and apricot§	6·8	441·2	22	5	100	6·8	1	8
	Desserts								
117	Crème fraiche dessert, peach (Finest)‖	15·6	320·5	28	8	150	23·4	7	9
118	Crème fraiche dessert, raspberry (Finest)‖	11·2	446·4	30	7	150	16·8	5	10
	Probiotic drinks								
119	Probiotic drink, orange‖	13·4	373·1	30	8	100	13·4	4	10
120	Probiotic drink, cranberry‖	12·2	409·8	56	9	100	12·2	7	10
121	Probiotic drink, original‖	12·2	409·8	34	5	100	12·2	4	10
122	Probiotic drink, pink grapefruit‖	13·1	381·7	60	18	100	13·1	8	10
123	Probiotic yoghurt, prune‖	14·3	349·7	44	10	170	24·3	11	10
124	Probiotic yoghurt, raspberry‖	14·3	349·7	45	10	170	24·3	11	10
125	Probiotic yoghurt, strawberry‖	14·3	349·7	52	14	170	24·3	13	10
Dried fruit and nuts									
126	Apricots, dried, ready to eat, bite size	36·5	137·0	32	7	60	21·9	7	10

Table 2. *Continued*

Food		Carbohydrate (g/100 g)	Experimental portion (g)	GI		Standard serving size (g)	Carbohydrate (g per serving)	GL (per serving)	Subjects (*n*)
				Mean	SEM				
127	Apricots, dried, ready to eat	36·0	138·9	31	6	60	21·6	7	8
128	Sultanas	69·4	72·0	58	11	60	41·6	24	8
129	Sultanas (Value)	69·4	72·0	56	8	60	41·6	24	10
130	Peaches, dried, ready to eat	36·9	135·5	35	5	60	22·1	8	8
131	Pears, dried, ready to eat	45·0	111·1	43	15	60	27·0	12	8
132	Mixed fruit, dried (Value)	67·9	73·6	60	7	60	40·7	6	10
133	Cashew nuts§	24·8	121·0	25	6	50	12·4	3	8
134	Cashew nut halves§	20·5	146·0	27	6	50	10·3	3	8
135	Cashew nuts, roasted and salted§	20·5	146·0	27	9	50	10·3	3	8
136	Cashew nuts, organic, roasted and salted§	23·4	128·2	25	12	50	11·7	3	8
137	Mixed nuts, roasted and salted§	34·6	144·5	24	10	50	17·3	4	9
138	Tropical fruit and nut mix (Finest)	55·7	89·8	49	7	50	27·9	14	9
139	Mixed nuts and raisins	31·0	161·3	21	5	50	15·5	3	9
140	Fruit and nut mix (Finest)	47·1	106·2	15	3	50	23·6	3	10

* For details of procedures, see p. 923.
† Made with water, cooked in the microwave according to manufacturer's instructions.
‡ Boiled in unsalted water for 10 min (egg tagliatelle, 7 min).
§ Both the test food and the reference food contained 25 g carbohydrate.
|| GI testing carried out by Reading Scientific Services Limited; both the test food and the reference food contained 25 g carbohydrate.

Discussion

The majority of GI values of foods tested in the current study compare well with previously published values (Foster-Powell *et al.* 2002). For example, in healthy subjects, the GI values for dried apricots (30), high-fibre bran (42), basmati rice (58), butter beans (28) and salted cashew nuts (22) reported in the international table of GI values (Foster-Powell *et al.* 2002) are similar to those shown in Table 2.

Small differences of less than 10–15 units in GI values are within the error associated with the measurement of GI (Wolever *et al.* 1991; Foster-Powell *et al.* 2002), however, there were a few values that were notably different to those of Foster-Powell *et al.* (2002). The high GI value (90 (SEM 11)) obtained for Value fruit loaf was unexpected as adding a low-GI ingredient such as dried fruit to a bread would be expected to lower its GI. The value obtained for bran flakes in the present study was considerably lower than the value published in 2002 by Foster-Powell *et al.* (absolute GI value 50 compared with 74). This highlights the need to test foods in the country of consumption if possible, as the processing conditions and the raw ingredients used may have a significant impact on GI. The GI of wholemeal pitta had not been published previously. Both the white and the wholemeal pitta fell into the medium GI category.

There are several factors that may alter the GI of a food, including the presence of other macronutrients such as fat and protein. The presence of large amounts of protein or fat may significantly reduce the glycaemic response by increasing insulin secretion and slowing gastric emptying (Collier *et al.* 1984; Nuttall *et al.* 1984). However, in the present study, protein showed only a moderate negative association with GI value and there was no association between GI value and fat content per 100 g of the test foods or per serving size tested. This reinforces the findings of Wolever *et al.* (1994) that the amount of protein or fat found in commonly consumed foods does not significantly affect glycaemic response.

With the increasing consumption of composite, ready-to-eat, meals in our society the current GI table will enable consumers and researchers alike to select low-GI foods for their respective needs. The majority of ready-to-eat meals produced low GI values. Only those products containing a high proportion of mashed potato, i.e. cottage pie, shepherds pie and sausage and mash, produced medium GI values.

The application of the GI to mixed meals is based on the assumption that the glycaemic response to different foods will be equally influenced by co-ingestion of protein or fat. However, Gulliford *et al.* (1989) found that the glycaemic response to two carbohydrate-rich foods was not equally modified by the co-ingestion of protein and fat. Therefore, it is important to test the GI of composite meals, instead of trying to calculate the GI from GI tables (Flint *et al.* 2004).

In summary, Table 2 provides reliable values of GI and GL for foods consumed in the UK. In addition to this, our data set provides GI values of several foods previously untested. This information will help prevent unnecessary replication of GI testing and will aid further research into the application of GI.

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