International Tables of Glycemic Index and Glycemic Load Values: 2008

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OBJECTIVE — To systematically tabulate published and unpublished sources of reliable glycemic index (GI) values.

RESEARCH DESIGN AND METHODS — A literature search identified 205 articles published between 1981 and 2007. Unpublished data were also included where the data quality could be verified. The data were separated into two lists: the first representing more precise data derived from testing healthy subjects and the second primarily from individuals with impaired glucose metabolism.

RESULTS — The tables, which are available in the online-only appendix, list the GI of over 2,480 individual food items. Dairy products, legumes, and fruits were found to have a low GI. Breads, breakfast cereals, and rice, including whole grain, were available in both high and low GI versions. The correlation coefficient for 20 staple foods tested in both healthy and diabetic subjects was $r = 0.94$ ($P < 0.001$).

CONCLUSIONS — These tables improve the quality and quantity of GI data available for research and clinical practice.

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The relevance of dietary glycemic index (GI) and glycemic load (GL) is debated. While the World Health Organization (1), the American Diabetes Association (2), Diabetes UK (3), and the Canadian Diabetes Association (4) give qualified support for the concept, many health professionals still consider GI and GL complex and too variable for use in clinical practice (5). The availability of reliable tables of GI is critical for continuing research and resolution of the controversy. New data have become available since previous tables were published in 2002 (6). Our aim was to systematically tabulate published and unpublished sources of reliable GI values, with derivation of the GL.

RESEARCH DESIGN AND METHODS

We conducted a literature search of MEDLINE from January 1981 through December 2007 using the terms "glyc(a)emic index" and "glyc(a)emic load." We restricted the search to human studies published in English using standardized methodology. We performed a manual search of relevant citations and contacted experts in the field. Unpublished values from our laboratory and elsewhere were included. Values listed in previous tables (6,7) were not automatically entered but reviewed first. Final data were divided into two lists. Values derived from groups of eight or more healthy subjects were included in the first list. Data derived from testing individuals with diabetes or impaired glucose metabolism, from studies using too few subjects ($n \leq 5$), or showing wide variability (SEM > 15) were included in the second list. Some foods were tested in only six or seven normal subjects but otherwise appeared reliable and were included in the first list. Two columns of GI values were created because both glucose and white bread continue to be used as reference foods. The conversion factor 100/70 or 70/100 was used to convert from one scale to the other. In instances where other reference foods (e.g., rice) were used, this was accepted provided the conversion factor to the glucose scale had been established. To avoid confusion, the glucose scale is recommended for final reporting. GL values were calculated as the product of the amount of available carbohydrate in a specified serving size and the GI value (using glucose as the reference food), divided by 100. Carbohydrate content was obtained from the reference paper or food composition tables (8). The relationship between GI values determined in normal subjects versus diabetic subjects was tested by linear regression. Common foods ($n = 20$), including white bread, cornflakes, rice, oranges, corn, apple juice, sucrose, and milk were used for this analysis.

RESULTS

Tables A1 and A2 (available in an online appendix at http://dx.doi.org/10.2337/dc08-1239) list 2,487 separate entries, citing 205 separate studies. Table A1, representing reliable data derived from subjects with normal glucose tolerance, contains 1,879 individual entries (75% of the total). Table A2 contains 608 entries, of which 491 values were determined in individuals with diabetes or impaired glucose metabolism (20% of the total). The correlation coefficient for 20 foods tested in both normal and diabetic subjects was $r = 0.94$ ($P < 0.001$; line of best fit $y = 0.9x + 9.7$ where x is the value in normal subjects). Table A2 also lists 60 values derived from groups of five or fewer subjects and 57 values displaying wide variability (SEM >15). A summary table (Table 1) comprising values for 62 common foods appears below. More reliable values are available for many foods, including carrots (GI = 39) and bananas (GI = 51).

CONCLUSIONS

The 2008 edition of tables of GI and GL has doubled the amount of data available for research and other applications. Most varieties of legumes, pasta, fruits, and dairy products are

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Table 1—*The average GI of 62 common foods derived from multiple studies by different laboratories*

High-carbohydrate foods		Breakfast cereals		Fruit and fruit products		Vegetables	
White wheat bread*	75 ± 2	Cornflakes	81 ± 6	Apple, raw†	36 ± 2	Potato, boiled	78 ± 4
Whole wheat/whole meal bread	74 ± 2	Wheat flake biscuits	69 ± 2	Orange, raw†	43 ± 3	Potato, instant mash	87 ± 3
Specialty grain bread	53 ± 2	Porridge, rolled oats	55 ± 2	Banana, raw†	51 ± 3	Potato, french fries	63 ± 5
Unleavened wheat bread	70 ± 5	Instant oat porridge	79 ± 3	Pineapple, raw	59 ± 8	Carrots, boiled	39 ± 4
Wheat roti	62 ± 3	Rice porridge/congee	78 ± 9	Mango, raw†	51 ± 5	Sweet potato, boiled	63 ± 6
Chapatti	52 ± 4	Millet porridge	67 ± 5	Watermelon, raw	76 ± 4	Pumpkin, boiled	64 ± 7
Corn tortilla	46 ± 4	Muesli	57 ± 2	Dates, raw	42 ± 4	Plantain/green banana	55 ± 6
White rice, boiled*	73 ± 4			Peaches, canned†	43 ± 5	Taro, boiled	53 ± 2
Brown rice, boiled	68 ± 4			Strawberry jam/jelly	49 ± 3	Vegetable soup	48 ± 5
Barley	28 ± 2			Apple juice	41 ± 2		
Sweet corn	52 ± 5			Orange juice	50 ± 2		
Spaghetti, white	49 ± 2						
Spaghetti, whole meal	48 ± 5						
Rice noodles†	53 ± 7						
Udon noodles	55 ± 7						
Couscous†	65 ± 4						
Dairy products and alternatives		**Legumes**		**Snack products**		**Sugars**	
Milk, full fat	39 ± 3	Chickpeas	28 ± 9	Chocolate	40 ± 3	Fructose	15 ± 4
Milk, skim	37 ± 4	Kidney beans	24 ± 4	Popcorn	65 ± 5	Sucrose	65 ± 4
Ice cream	51 ± 3	Lentils	32 ± 5	Potato crisps	56 ± 3	Glucose	103 ± 3
Yogurt, fruit	41 ± 2	Soya beans	16 ± 1	Soft drink/soda	59 ± 3	Honey	61 ± 3
Soy milk	34 ± 4			Rice crackers/crisps	87 ± 2		
Rice milk	86 ± 7						

Data are means ± SEM. *Low-GI varieties were also identified. †Average of all available data.

still classified as low-GI foods (55 or less on the glucose reference scale). Breads, breakfast cereals, rice, and snack products, including whole-grain versions, are available in both high- (70 or greater) and low-GI forms. Most varieties of potato and rice are high GI, but lower GI cultivars were identified. Many confectionary items, such as chocolate, have a low GI, but their high saturated fat content reduces their nutritional value. The GI should not be used in isolation; the energy density and macronutrient profile of foods should also be considered (1). The high correlation coefficient (r = 0.94) between values derived from testing the same foods in normal and diabetic subjects indicates that GI values in Table A1 are relevant to dietary interventions in people with diabetes.

Although data quality has been improved, many foods have been tested only once in 10 or fewer subjects, and caution is needed. Repeated testing of certain products indicates that white and wholemeal bread have remained remarkably consistent over the past 25 years, but other products appear to be increasing in GI. This secular change may arise because of efforts on the part of the food industry to make food preparation more convenient and faster cooking. Some foods, such as porridge oats, show variable results, which may reflect true differences in refining and processing that affect the degree of starch gelatinization (9). Users should note that manufacturers sometimes give the same product different names in different countries, and in some cases, the same name for different items. Kellogg's Special K and All-Bran, for example, are different formulations in North America, Europe, and Australia.

Assignment of GI values to foods requires knowledge of local foods. Ideally, branded product information is available because manufacturers prepare and process foods, particularly cereal products, in different ways. This variability is not unique to the GI but true of many nutrients, including saturated fat and fiber. In the absence of specific product GI information, these tables provide the basis for extrapolation. In the case of low-carbohydrate products, a GI value of 40 for vegetables, 70 for flour products, and 30 for dairy foods could be assigned.

In summary, the 2008 edition of the international tables of GI improves the quality and quantity of reliable data available for research and clinical practice. The data in Table A1 should be preferred for research and coding of food databases.

The values listed in Table A2 may be helpful in the absence of other data.

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