

International Tables of Glycemic Index and Glycemic Load Values: 2008

FIONA S. ATKINSON, RD
KAYE FOSTER-POWELL, RD
JENNIE C. BRAND-MILLER, PHD

OBJECTIVE— To systematically tabulate published and unpublished sources of reliable glycemic index (GI) values.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 Unpublished data were also included where the data quality could be verified.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.

Diabetes Care 31:2281–2283, 2008

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 Our aim was to systematically tabulate published and unpublished sources of reliable GI values, with derivation of the GL.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 Unpublished values from our laboratory and elsewhere were included.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

.....

From the Institute of Obesity, Nutrition and Exercise, University of Sydney, New South Wales, Australia.

Corresponding author: J. Brand-Miller, j.brandmiller@usyd.edu.au.

Received 8 July 2008 and accepted 13 September 2008.

Published ahead of print at <http://care.diabetesjournals.org> on 3 October 2008. DOI: 10.2337/dc08-1239.

J.B.M. is the director of a not-for-profit GI-based food endorsement program in Australia. F.S.A. is employed to manage the University of Sydney GI testing service.

© 2008 by the American Diabetes Association. Readers may use this article as long as the work is properly cited, the use is educational and not for profit, and the work is not altered. See <http://creativecommons.org/licenses/by-nc-nd/3.0/> for details.

The costs of publication of this article were defrayed in part by the payment of page charges. This article must therefore be hereby marked “advertisement” in accordance with 18 U.S.C. Section 1734 solely to indicate this fact.

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*	Cornflakes	Apple, raw†	Potato, boiled
Whole wheat/whole meal bread	Wheat flake biscuits	Orange, raw†	Potato, instant mash
Specialty grain bread	Porridge, rolled oats	Banana, raw†	Potato, french fries
Unleavened wheat bread	Instant oat porridge	Pineapple, raw	Carrots, boiled
Wheat roti	Rice porridge/congee	Mango, raw†	Sweet potato, boiled
Chapati	Millet porridge	Watermelon, raw	Pumpkin, boiled
Corn tortilla	Muesli	Dates, raw	Plantain/green banana
White rice, boiled*		Peaches, canned†	Taro, boiled
Brown rice, boiled		Strawberry jam/jelly	Vegetable soup
Barley		Apple juice	
Sweet corn		Orange juice	
Spaghetti, white			
Spaghetti, whole meal			
Rice noodles†			
Udon noodles			
Couscous†			
Dairy products and alternatives	Legumes	Snack products	Sugars
Milk, full fat	Chickpeas	Chocolate	Fructose
Milk, skim	Kidney beans	Popcorn	Sucrose
Ice cream	Lentils	Potato crisps	Glucose
Yogurt, fruit	Soya beans	Soft drink/soda	Honey
Soy milk		Rice crackers/crisps	
Rice milk			

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 whole-meal 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.

References

1. Mann J, Cummings J, Englyst H, Key T, Liu S, Riccardi G, Summerbell C, Uauy R, van Dam R, Venn B, Vorster H, Wiseman M: FAO/WHO Scientific Update on carbohydrates in human nutrition: conclusions. *Eur J Clin Nutr* 61:S132–S137, 2007
2. Sheard N, Clark N, Brand-Miller J, Franz M, Pi-Sunyer FX, Mayer-Davis E, Kulkarni K, Geil P: Dietary carbohydrate (amount and type) in the prevention and management of diabetes. *Diabetes Care* 27:2266–2271, 2004
3. Nutrition Subcommittee of the Diabetes Care Advisory Committee of Diabetes UK: The implementation of nutritional advice for people with diabetes. *Diabet Med* 20: 786–807, 2003
4. Canadian Diabetes Association: Guidelines for the nutritional management of diabetes mellitus in the new millennium. A position statement by the Canadian Diabetes Association. *Can J Diabetes Care* 23: 56–69, 2000
5. Franz M: The glycemic index: not the most effective nutrition therapy intervention. *Diabetes Care* 26:2466–2468, 2003
6. Foster-Powell K, Holt SH, Brand-Miller JC: International table of glycemic index and glycemic load values: 2002. *Am J Clin Nutr* 76:5–56, 2002
7. Foster-Powell K, Miller J: International tables of glycemic index. *Am J Clin Nutr* 62: S871–S90, 1995
8. U.S. Department of Agriculture, Agricultural Research Service: *USDA National Nutrient Database for Standard Reference* [article online], 2007. Release 20. Available at <http://www.ars.gov/ba/bhnrc/ndl>. Accessed 20 May 2008
9. Bjorck I, Granfeldt Y, Liljeberg H, Tovar J, Asp N-G: Food properties affecting the digestion and absorption of carbohydrates. *Am J Clin Nutr* 59:S699–S705, 1994