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Glycemic index and glycemic load of commercial Italian foods

F. Scazzina [a], M. Dall'Asta [a], M.C. Casiraghi [b], S. Sieri [c], D. Del Rio [a], N. Pellegrini [a,*], F. Brighenti [a]

[a] Human Nutrition Unit, Department of Food Science, University of Parma, Italy
[b] Human Nutrition Unit, Department of Food, Environmental and Nutritional Sciences (DeFENS), University of Milan, Italy
[c] Epidemiology and Prevention Unit, Fondazione IRCCS Istituto Nazionale dei Tumori, Milano, Italy

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Abstract *Background and aim:* The glycemic index (GI) and glycemic load (GL) are useful parameters in the nutritional classification of carbohydrate foods. Diets characterized by a low GI and/or a low GL have been repeatedly and independently associated with decreased risk of diabetes and other chronic diseases. The aim of this study is to report the GI and GL value of carbohydrate-rich foods available on the Italian market and mostly consumed in Italy.
Methods and results: GI values were determined according to FAO/WHO (1997) and ISO (2010). Overall, the 141 commercial foods that were analyzed represent food categories that are the source of >80% carbohydrate intake in Italy. The food items chosen were based mainly on the market share of the brand within each food category and grouped into 13 food categories: 1) beverages: fermented milk drink, juice, smoothie, soft drink; 2) biscuits; 3) breads; 4) bread substitutes; 5) breakfast cereals; 6) cakes and snacks; 7) candy and confectionery; 8) cereals; 9) desserts and ice-creams; 10) marmalade and jam; 11) pasta; 12) pizza; 13) sugar and sweetener.
Conclusion: This database of commercial Italian foods partly overcomes the lack of information on GI and GL of local foods, contributing to a better understanding of the association between GI/GL and health and providing a more informed choice to Italian consumers and health practitioners.

Introduction

The glycemic index (GI) was developed to systematically classify foods according on their ability to raise postprandial glycemia [1]. Carbohydrates in foods with a low GI are more slowly digested and absorbed and, consequently, diets with a low GI are beneficial in controlling postprandial plasma glucose excursions [2]. Since the overall impact of one food on postprandial response is due to the combination of GI and the amount of carbohydrate in that food, a derived index has been proposed [3]. The glycemic load (GL) is defined as the mathematical product of the grams of available carbohydrate in the food portion and the food's GI, divided by 100. The physiological validity of the GL concept as predictor of postprandial glycemia and insulin demand has been demonstrated for foods high in carbohydrate and low in fat and protein [4]. Subsequently, GL was standardized to the energy of the food portion consumed (GL/1000 kJ) for better representing carbohydrate-based foods combined with fat and protein [5]. The food GL, standardized to energy, is the single best predictor of the glycemic response of foods, taking into consideration not only the quantity of carbohydrates but also the presence of other nutrients [6].

In nutritional epidemiology the use of GI and/or GL, as a descriptor of diets and food patterns, is common. Diets low

* Corresponding author. Tel.: +39 (0)521 903907.
E-mail address: nicoletta.pellegrini@unipr.it (N. Pellegrini).

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in GI and GL, but not in total carbohydrates, are associated to lower type 2 diabetes mellitus (T2DM) risk [7,8], cardiovascular disease (CVD) risk [9,10], levels of pro-inflammatory markers and fasting insulin [2]. However, conflicting results have appeared in the literature. For example, opposing conclusions have been reported on the risk of T2DM, where no association with diabetes risk was observed in a random subcohort ($n = 16{,}835$) of the EPIC study [11] while, on the other hand, GI/GL resulted to be important factors in diabetes prevention in the EPIC-Netherlands cohort [12]. However, as also highlighted by the authors of the above-mentioned papers, a major methodological issue for the validity of GI/GL data in epidemiological research is the use of international GI/GL food databases in local contexts, which may not correctly represent the actual products present on the local market. A second methodological issue is the limited number of foods or preparations mapped for GI/GL in an ever-growing food market.

Despite some doubts on the validity of the GI concept raised by recent guideline documents [13], the ability to control postprandial glycemia is considered to be extremely useful by most health institutions [6,14–20].

In this context, there is need to communicate information on GI/GL to the general public and health professionals and to establish better and unbiased tools for nutritional research, with a focus on foods and preparations that are consumed locally. Due to the lack, to date, of a detailed set of data including commercial food products sold on the Italian market, the aim of the present study was to measure a sufficiently large and detailed set of GI/GL values of commercial foods to be the further applied to present and future epidemiological studies.

Methods

All the analyses have been performed at the Department of Food Science (Nutrition Unit) of the University of Parma and at the Department of Food, Environmental and Nutritional Sciences (DeFENS) of the University of Milan over 10 year period between 2005 and 2015. The GI values were determined following the method described by the Food and Agriculture Organization/World Health Organization [16] and, later, applying the guidelines set up by the International Standards Organisation [21].

Subjects

Healthy subjects were recruited from the local communities during the last 10 years. All subjects met the inclusion criteria: non-smoking, aged 18–69 years, stable body weight, BMI of 19–25 kg/m^2, normal glucose tolerance, regular physical activity, normal dietary habits, no history of eating disorders, no gastrointestinal disorders, no diabetes, no medications known to affect glucose tolerance, no pregnancy, no breastfeeding, not intolerant or allergic to any of the foods. All the subjects of this study were previously informed on the details of the protocol, and about the risks involved in participation and they gave their written informed consent to participate to the study, according to the Helsinki declaration on human rights. The studies were case-by-case approved by the ethical committees of the University of Parma and of the University of Milan.

Foods

The 13 food categories investigated were: 1) beverages: fermented milk drink, juice, smoothie, soft drink; 2) biscuits; 3) breads; 4) bread substitutes; 5) breakfast cereals; 6) cakes and snacks; 7) candy and confectionery; 8) cereals; 9) desserts and ice-creams; 10) marmalade and jam; 11) pasta; 12) pizza; 13) sugar and sweeteners, representing the source of >80% of the carbohydrate intake as extrapolated from dietary intake data obtained in two cohort studies in northern Italy [22,23]. Food items were commercial products belonging to the above categories selected according to the market share of the producer within each category. In addition, specialty foods or different brands were also selected in order to expand the category surveyed. Each food was purchased in a single batch on the local market or directly obtained by the producer in sufficient amounts to provide the required number of food portions to the selected number of volunteers. Portion sizes were calculated according to manufacturers' nutrition information. All food items were portioned to provide either 50 g of available carbohydrate or 25 g for foods with low available carbohydrates content. Three items in candy and confectionary category (Tic Tac – two flavors – Mon Cheri and Pocket Espresso to GO) were administered in a smaller portion (12.5 g of available carbohydrates) because of the unrealistic portion and of the alcohol and caffeine content, respectively. Pasta and wholegrain cereal samples were cooked following the same procedure for each food: one portion of pasta or wholegrain cereals was cooked in 1 L of boiling water with 5 g of salt for the time indicated on the pack label. The reference meal was glucose monohydrate in iso-carbohydrate amount.

Experimental procedures

The volunteers attended each testing session after a 12 h overnight fast, having been instructed to consume the same meal the evening before each test day, and not to drink alcohol or to perform vigorous physical exercise. Furthermore, subjects followed a controlled diet the day before the test, excluding dietary fiber-rich foods to avoid any second meal effect [24]. Generally, each group of volunteers tested from 2 to 10 food items.

Subjects consumed the provided food portion within 15 min, with 500 ml of still water as the only beverage. They remained seated during the 2 h of the study and were not permitted to further eat or drink until the end of session. The reference meal, glucose monohydrate, was dissolved in 500 ml of water and was consumed by the subjects in two or three separate occasions, at the beginning and at the end of the assigned set of products, and in