Nutrition 46 (2018) 53–61

Contents lists available at ScienceDirect

Nutrition

journal homepage: www.nutritionjrnl.com

Applied nutritional investigation

Glycemic index and glycemic load of the diets of Japanese adults: the 2012 National Health and Nutrition Survey, Japan

Kentaro Murakami Ph.D. [a,*], Satoshi Sasaki M.D., Ph.D. [b]

[a] *Interfaculty Initiative in Information Studies, University of Tokyo, Tokyo, Japan*
[b] *Department of Social and Preventive Epidemiology, School of Public Health, University of Tokyo, Tokyo, Japan*

ARTICLE INFO

Article history:
Received 11 April 2017
Accepted 27 August 2017

Keywords:
Glycemic index
Glycemic load
Food intake
Nutrient intake
Japan
National survey

ABSTRACT

Objective: The aim of this study was to examine the dietary glycemic index (GI) and glycemic load (GL) of Japanese adults, as well as their nutritional correlates, in the 2012 National Health and Nutrition Survey, Japan.

Method: Dietary data from 15 618 adults aged ≥20 y, collected using a 1-d weighed dietary record, were analyzed. The GI of foods was assigned based on a stepwise published strategy using values from common GI databases.

Results: Mean (SD) dietary GI and GL were 65.9 (4.9) and 190.1 (59.7), respectively, for men and 63.9 (5) and 149.1 (44.1), respectively, for women. Regardless of sex, the top contributor to dietary GL was white rice (GI = 76; >50%), followed by bread (6–8%), noodles (5–6%), and confectioneries (4–7%). White rice was not only positively associated with dietary GI but also contributed most (∼38%) to interindividual variation in dietary GI. For dietary GL, ∼90% of the interindividual variation was explained by carbohydrate-rich foods (mainly white rice; ∼50%), all of which were positive predictors. At the nutrient level, only carbohydrate intake was positively associated with dietary GI and GL, whereas intakes of all other nutrients including saturated fatty acid and sodium showed inverse associations (with some exceptions).

Conclusion: Dietary GI and GL of Japanese adults were primarily determined by the high GI food white rice, and were thus relatively high compared with values observed in Western countries. A low GI and GL diet was associated with both favorable (higher intakes of micronutrients) and unfavorable (higher intakes of saturated fatty acid and sodium) aspects of dietary intake patterns.

Introduction

Accumulated evidence suggests a potential role of diets with a low glycemic index (GI; a measure of carbohydrate quality) [1] and glycemic load (GL; a measure of carbohydrate quality and quantity) [2] in the prevention and management of chronic diseases [3], including type 2 diabetes [4]. Findings have not always been consistent, however, particularly with regard to obesity [5–8]. Such heterogeneous results may be at least partly due to cultural differences in dietary intake patterns in relation to dietary GI and GL. In Western populations, dietary GL has generally been associated with many carbohydrate-rich foods, and hence strongly with carbohydrate intake, whereas dietary GI has been associated with not only higher intakes of major carbohydrate-rich foods (such as breads and potatoes) but also lower intakes of other low- or noncarbohydrate foods (such as fruit and dairy products). However, the associations between dietary GI and GL and intake of each of the food groups and nutrients vary considerably in magnitude and direction, depending on different food culture contexts [6–14]. These differences highlight the need to gather country-specific data on dietary GI and GL to better inform nutrition and public health policy in each country [14].

The diets consumed by Japanese people are typically characterized by high intakes of white rice, soybean products, fish,

This study was supported in part by the Grants-in-Aid for Young Scientists (B) from the Ministry of Education, Culture, Sports, Science and Technology of Japan (KM, grant number 15K16213). The Ministry of Education, Culture, Sports, Science and Technology of Japan had no role in the design, analysis, or writing of this article. KM contributed to the concept and design of the study, statistical analysis, data interpretation, and manuscript writing. SS assisted in the writing of the manuscript. Both authors read and approved the final manuscript.
* Corresponding author. Tel: +81-3-5841-7872; fax: +81-3-5841-7873.
E-mail address: kenmrkm@m.u-tokyo.ac.jp (K. Murakami).

https://doi.org/10.1016/j.nut.2017.08.012
0899-9007/

seaweeds, and green tea [15]. Furthermore, Japanese diets are known to be high in dietary GI and GL (range of median values: 65–67 and 141–185, respectively; GI for glucose = 100) [16–20] compared with Western countries (range of median values: 50–61 and 80–140, respectively; GI for glucose = 100) [3], mainly because white rice, a food with a high GI (76), is the major contributor to dietary GI and GL (46–64%) [16,17,20,21]. Thus, associations of dietary GI and GL with food groups and nutrient intakes may differ between Japanese and Western diets. Information about the nutritional correlates of dietary GI and GL in Japanese populations is sparse [21], however, and this idea remains speculative. More importantly, previous studies on dietary GI and GL of Japanese have been conducted either in a limited number of individuals [17], based on the questionnaire-based dietary assessment with a very limited number of food items [16,20,21], or mainly among women [16,20,21]. Further research based on detailed dietary intake data in a more representative sample of Japanese is warranted.

Therefore, the aim of the present study was to examine dietary GI and GL of Japanese adults, as well as nutritional correlates at both the food group and nutrient level, based on dietary intake data from the weighed dietary record in the 2012 National Health and Nutrition Survey, Japan (NHNSJ).

Materials and methods

National Health and Nutrition Survey, Japan

Data source

The NHNSJ, which has been running since 1945, is an annual nationwide nutrition survey conducted by local public health centers under the supervision of the Japanese Ministry of Health, Labour and Welfare. The present cross-sectional study was based on data from the 2012 NHNSJ. Full details of the 2012 NHNSJ have been provided elsewhere [15,22,23]. Briefly, 475 census units (out of about 1 million) were randomly sampled as survey areas based on the population census. All noninstitutionalized Japanese people aged ≥1 y living in these areas (∼61 000) were invited to participate. The survey was conducted from October 25 to December 7, 2012. In all, 12 750 of 24 555 eligible households (52%) participated in the survey [15].

This survey was conducted according to the guidelines laid down in the Declaration of Helsinki, and verbal informed consent was obtained from each individual participant. Under the Statistics Act, the Ministry of Health, Labour and Welfare anonymized individual-level data collected from the NHNSJ, and provided the first author with the datasets for this study. In accordance with the Ethical Guidelines of Epidemiological Research established by the Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Health, Labour and Welfare [23], institutional review board approval was not required for this analysis.

Anthropometric measurements

Anthropometric measurements were performed on ∼90% of the participants by trained fieldworkers using standardized procedures. Height (to the nearest 0.1 cm) and weight (to the nearest 0.1 kg) were measured while the participant was barefoot and wearing light clothes only. Otherwise, height and weight were measured either by other household members at home or self-reported. Standardization of the instruments for height and weight measurement was not feasible in this survey [15].

Dietary assessment

Dietary intake data were collected using a 1-d semiweighted household dietary record, the procedure of which has been described in detail elsewhere [15,24]. Briefly, the participant and the main record-keeper were given both written and verbal instructions by trained fieldworkers (registered dietitians) on the purpose of the dietary record and how to weigh and record food items consumed by household members in the diary. The main record-keeper was asked to record and weigh all foods and drinks consumed by household members on the recording day (thus, the dietary record included data on all members of household). When household members shared foods from the same dish, the record-keeper was asked to record approximate proportions of the food taken by each member so that the dietary intake of each individual could be calculated. When weighing was not possible (e.g., eating out), the record-keeper was asked to record as much information as possible, including the portion size consumed and details of any leftovers. Each household freely selected a recording day from any day except Sunday, national holidays, and days with a special event (e.g., wedding party or funeral). Although information on who was the main record-keeper was not formally collected in the survey [15], it was assumed that the main cook in the household (mainly women in Japanese households) was responsible for diet recording. Trained fieldworkers visited each household and checked the completeness of food recording, and if necessary, additional information was added.

Assessment of nondietary variables

Using a questionnaire, information on basic characteristics including sex, age, smoking status, alcohol drinking, and habitual exercise were collected.

Data handling

Analytic sample

There were 30 639 participants aged ≥20 y in the 2012 NHNSJ. Of these, the number of participants with missing information on dietary intake, anthropometric measurements, and lifestyle variables was 3913, 8593, and 14 044, respectively (some had more than one missing piece of information) [15]. After excluding 246 lactating and 136 pregnant women, the final sample used in this analysis comprised 6552 men and 9066 nonlactating and nonpregnant women aged ≥20 y with complete information on the variables of interest. The participants included in the present analysis (N = 15 618) differed somewhat from those excluded from the analysis (n = 1032–15 021, depending on variable). The excluded individuals were more likely to be men, be younger, be current smokers, and be physically inactive and to have lower mean energy intake and body mass index (BMI; all $P < 0.0001$).

Dietary variables

Estimates of daily intake for foods, energy, and selected nutrients in each individual were calculated from the record of household food consumption and, for shared dishes or foods, approximate proportions consumed by each household member, based on the Standard Tables of Food Composition in Japan, 2005 [25]. Values of food and nutrient intake were energy-adjusted using the density method (i.e., percent of energy for energy-providing nutrients and amount per 4184 kJ of energy for foods and other nutrients). The nutrients examined in the present study included protein, fat, saturated fatty acids (SFAs), monounsaturated fatty acids (MUFAs), polyunsaturated fatty acids (PUFAs), carbohydrates, alcohol, dietary fiber, and selected minerals (including sodium, potassium, calcium, magnesium, and iron) and vitamins (including vitamins A, E, C, and folate). These were selected mainly to allow the comprehensive assessment of dietary intake in consideration of the current dietary intake patterns of Japanese [15].

The utility of this household dietary record for estimating dietary intake at the individual level in the Japanese population has previously been examined [24]. Briefly, dietary intakes among young women (∼20 y of age) estimated by this 1-d household dietary record by mothers (mean age 49 y) were compared with those estimated by a 1-d weighed dietary record that was independently conducted by the young women themselves (n = 32). Mean differences between intakes estimated by the two methods were 6.2% for energy, 5.7% for protein, 6.7% for fat, and 6.3% for carbohydrate, whereas Pearson correlation coefficients were 0.90 for energy, 0.89 for protein, 0.91 for fat, and 0.90 for carbohydrate.

Other variables

In accordance with the NHNSJ report [15], six age categories were defined (20–29, 30–39, 40–49, 50–59, 60–69, or ≥70 y). BMI (kg/m^2) was calculated as weight (kg) divided by height (m) squared. Weight status was defined based on BMI according to World Health Organization recommendations [26]: underweight (<18.5 kg/m^2), normal (≥18.5 to <25 kg/m^2), overweight (≥25 to <30 kg/m^2), and obese (≥30 kg/m^2). The following variables were also created: smoking status (never, past, or current), habitual alcohol drinking (no or yes), and habitual exercise (no or yes).

Calculation of dietary glycemic index and glycemic load

To calculate dietary GI and GL, GI values with glucose as the reference scale (GI for glucose = 100) were assigned to individual food items (N = 1643) in the dietary record, on the basis of the following seven-step strategy developed based on previous studies [6,27–30].

1. Determine whether the item has ≤2.5 g available carbohydrate per 100 g. If yes, assign a GI value of 0 (43% of food items). If no, go to step 2.
2. Determine whether there is a direct link to a food in the following data sources:
- The latest international table of GI [31], the Sydney University Glycemic Index Research Service online database [32],