Dietary Fiber and Glucose Tolerance in Japanese Brazilians

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Although the evidence for a protective effect of high total dietary fiber intakes on diabetes appears to be strong (1), the role of food sources of dietary fiber in the etiology of impaired glucose disturbances is poorly understood (2). Epidemiological studies suggest that high intakes of whole grain foods (3,4) and vegetables (5–7) may prevent diabetes. On the other hand, the impact of consumption of fruits and fruit juices (5,6,8), legumes (5,9), and refined grains (3,10) has been investigated in a few controversial investigations.

Here, we evaluated the relationship between fiber-related dietary factors and the risk of impaired fasting glucose (IFG) and impaired glucose tolerance (IGT) among Japanese Brazilians.

RESEARCH DESIGN AND METHODS— In 2000, Japanese Brazilians >30 years of age living in Bauru, São Paulo State, Brazil (n = 1,751), were invited to participate. Cross-sectional data from 1,283 first- and second-generation subjects were available (73.3%) (11). For the present analysis, subjects with self-reported impaired glucose disturbances (IFG, IGT, or diabetes; n = 220) and newly diagnosed diabetes (n = 276) whose treatment could interfere in food habits were excluded.

Smoking status, drinking habits, and physical activity were assessed using a structured questionnaire. Height, weight, and waist circumference were measured using standardized approaches (11). Central obesity was defined as a waist circumference ≥0.90 m for men and ≥0.80 m for women (12). The last two of three measures of blood pressures using an automatic device were considered; hypertension was defined according to the World Health Organization (13).

Food consumption was assessed using a validated food frequency questionnaire (11,14). Dietary exposures included intakes of total fiber, refined-grain foods (rice, bread, and pasta), legumes (beans, lentils, and peas), total fruits and fruit juices, and vegetables.

Serum cholesterol and triacylglycerol levels were measured enzimatically to define dyslipidemia (15). A standard 75-g oral glucose tolerance test was given according to World Health Organization criteria for glucose tolerance status (16), considering isolated IGT or IGT+IFG as two different categories.

All dietary variables were log transformed, and energy-adjusted values were calculated by the residual method. Separate logistic regression models were used to calculate the odds ratio (OR) for three outcomes (IFG, isolated IGT, and IGT+IFG) with individuals in the lowest tertile category of total dietary fiber and food groups as the referent category. OR were adjusted for sex, age, generation, central obesity, smoking, schooling, hypertension or dyslipidemia, physical activity, total energy intake, energy-adjusted tertile intakes of total dietary fiber, and cholesterol.

RESULTS— The mean age of the 787 study participants (55% female) was 55 (12) years. The OR for three glucose tolerance outcomes, according to energy-adjusted tertile intakes of total dietary fiber and fiber-contributing foods, are shown in Table 1. Subjects in the highest tertile for total dietary fiber had an increase of 70% in the risk of IFG when compared with subjects in the lowest tertile. However, no association was found between total dietary fiber intake and isolated IGT or IGT+IFG. The relation between total dietary fiber and risk of IFG was no longer significant (OR 1.31 [95% CI 0.76–2.26]) after further adjustments for tertile intakes of refined grains, legumes, and fruits/juices. There was a dose-response relationship between IFG, isolated IGT, or IGT+IFG and increasing total intakes of refined grains together with fruits/juices.

CONCLUSIONS— To our knowledge, this is the first observational study to examine associations between dietary sources of fiber and prevalence of IFG, isolated IGT, and IGT with IFG. Previous evidences support that the degree of insulin resistance may alter the effect of carbohydrate-containing food on blood glucose (17). Given that Japanese Brazilians are at increased risk for impaired glucose disturbances and the limitations inherent to the cross-sectional nature of our data precluding the associations as causal ones, the extrapolation of our findings must be carefully considered.

Our findings are consistent with those of the Melbourne Collaborative Cohort Study (10), in which the highest intake of white bread was associated with a 37% increase in the risk of diabetes; however, neither total dietary fiber nor fiber from different sources was associated with diabetes. In the Framingham Offspring Cohort Study (3), fiber from cereals, mostly whole grain, was inversely related to metabolic syndrome and homeostasis model assessment insulin resistance, whereas total dietary fiber and fiber

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*A complete list of the Japanese-Brazilian Diabetes Study Group can be found in the APPENDIX.
Abbreviations: IFG, impaired fasting glucose; IGT, impaired glucose tolerance.
A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

Table 1—*OR (95% CI) of IGT across tertiles of carbohydrate-related dietary factors*

	Median intake (g/day)	Glucose tolerance status*		
		IFG	IGT + IFG	Isolated IGT
n		239	189	92
Total fiber				
Tertile 1	11.8	1.00	1.00	1.00
Tertile 2	15.5	1.71 (1.09–2.69)	1.19 (0.71–1.98)	1.10 (0.57–2.12)
Tertile 3	22.6	1.70 (1.06–2.74)	1.49 (0.88–2.51)	1.51 (0.80–2.85)
P for trend		0.024	0.13	0.17
Fruits and fruit juices				
Tertile 1	131.5	1.00	1.00	1.00
Tertile 2	306.3	0.87 (0.53–1.41)	0.83 (0.46–1.49)	1.36 (0.67–2.72)
Tertile 3	576.2	1.02 (0.56–1.86)	1.29 (0.66–2.54)	1.41 (0.59–3.32)
P for trend		0.96	0.41	0.51
Vegetables				
Tertile 1	115.6	1.00	1.00	1.00
Tertile 2	180.1	0.95 (0.59–1.51)	0.77 (0.45–1.33)	0.40 (0.19–0.80)
Tertile 3	260.0	1.28 (0.79–2.08)	1.28 (0.74–2.24)	1.33 (0.70–2.54)
P for trend		0.34	0.33	0.27
Refined grains				
Tertile 1	265.4	1.00	1.00	1.00
Tertile 2	474.5	1.24 (0.78–1.96)	0.91 (0.54–1.53)	1.22 (0.64–2.30)
Tertile 3	551.3	1.52 (0.94–2.46)	1.32 (0.78–2.23)	1.72 (0.86–3.42)
P for trend		0.07	0.29	0.15
Legumes				
Tertile 1	2.0	1.00	1.00	1.00
Tertile 2	7.1	1.38 (0.86–2.22)	1.18 (0.69–1.98)	2.68 (1.35–5.32)
Tertile 3	17.6	1.29 (0.82–2.06)	1.14 (0.68–1.91)	1.80 (0.87–3.73)
P for trend		0.27	0.63	0.16
Refined grains and legumes				
Tertile 1	272	1.00	1.00	1.00
Tertile 2	478	1.24 (0.78–1.96)	0.98 (0.58- 1.64)	1.31 (0.69–2.49)
Tertile 3	568	1.44 (0.89–2.34)	1.35 (0.79–2.29)	1.73 (0.87–3.45)
P for trend		0.12	0.25	0.11
Refined grains and fruits				
Tertile 1	571	1.00	1.00	1.00
Tertile 2	723	1.23 (0.77–1.94)	1.38 (0.81- 2.37)	1.48 (0.75–2.92)
Tertile 3	1,065	1.99 (1.11–3.57)	2.53 (1.34–4.79)	2.39 (1.08–5.29)
P for trend		0.031	0.005	0.04

Data are OR (95% CI), unless otherwise indicated. *Tertile categories are based on energy-adjusted values using the residual method. Normal subjects according to glucose tolerance status = 267. Logistic regression models adjusted by sex, age (years), generation (first/second), central obesity (yes/no), smoking (never, past/current), education (< 1, 1–8, or ≥8 years of school), hypertension or dyslipidemia (yes/no), practice of leisure time physical activity (yes/no), total energy intake, dietary cholesterol, and fiber (for foods).

from fruits, vegetables, and legumes were not associated, emphasizing the distinct roles of quantity and quality of dietary fiber on insulin action and degree of insulin resistance.

Epidemiological evidence of the role of refined grain on markers of glucose homeostasis is unclear. Four large prospective studies in the U.S. and one in Finland showed no significant relationship between fiber from refined grains and diabetes incidence after multiple adjustments (4,9,18). Conversely, taking into account the ratio of refined to whole grain intake, American women on the highest quintile of refined grain consumption had a 57% increase in diabetes incidence (18).

Another relevant fiber-contributing food in our study was the group of fruits and fruit juices. The intake levels of fruits and juices in our study population were very high: the median intake of fruits in the highest tertile of energy-adjusted dietary fiber was 500g/day (6.3 servings/day). Although water-soluble fiber-contributing foods have been related to good metabolic control in diabetic individuals, fruits and fruit juices are also fructose-rich foods, and evidence suggests excessive fructose consumption can play a deleterious role in glycemic control among high-risk individuals prone to insulin resistance syndrome (19).

In conclusion, our data suggest that the quantity and quality of dietary fiber play different roles on glucose metabolism. Very high intakes of fruit and fruit juices, white bread, and refined rice that are typical in Brazilian diets may increase risk of impaired glucose disturbances among Japanese Brazilians. The investigation of the quantity of total dietary fiber intake, not taking into account the food sources, may fail to explain its association with the development of impaired glucose disturbance.

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APPENDIX

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