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Dietary ω-3 fatty acid and ω-3: ω-6 fatty acid ratio predict improvement in glucose disturbances in Japanese Brazilians

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Abstract

Objective: We investigated whether lifestyle-induced changes in dietary fat quality are related to improvements on glucose metabolism disturbances in Japanese Brazilians at high risk of type 2 diabetes.
Methods: One hundred forty-eight first- and second-generation subjects with impaired glucose tolerance or impaired fasting glycemia who attended a lifestyle intervention program for 12 mo were studied in the city of Bauru, State of São Paulo, Brazil. Dietary fatty acid intakes at baseline and after 12 mo were estimated using three 24-h recalls. The effect of dietary fat intake on glucose metabolism was investigated by multiple logistic regression models.
Results: At baseline, mean ± standard deviation age and body mass index were 60 ± 11 y and 25.5 ± 4.2 kg/m^2, respectively. After 12 mo, 92 subjects had normal plasma glucose levels and 56 remained in prediabetic conditions. Using logistic regression models adjusted for age, gender, generation, basal intake of explanatory nutrient, energy intake, physical activity, and waist circumference, the odds ratios (95% confidence intervals) for reversion to normoglycemia were 3.14 (1.22–8.10) in the second tertile of total ω-3 fatty acid, 4.26 (1.34–13.57) in the second tertile of eicosapentaenoic acid, and 2.80 (1.10–7.10) in the second tertile of linolenic acid. Similarly, subjects in the highest tertile of ω-3:ω-6 fatty acid ratio showed a higher chance of improving glucose disturbances (2.51, 1.01–6.37).
Conclusions: Our findings support the evidence of an independent protective effect of ω-3 fatty acid and of a higher ω-3:ω-6 fatty acid ratio on the glucose metabolism of high-risk individuals.

Keywords: Dietary fatty acids; ω-3 fatty acid; ω-3 to ω-6 fatty acids ratio; Glucose metabolism; Migrants

Introduction

The importance of primary prevention of type 2 diabetes has been increasingly recognized, and the identification of modifiable risk factors, such as usual food intake, for glucose disturbances is of utmost relevance [1]. Recent trials have strongly suggested that type 2 diabetes can be prevented by the adoption of a healthy lifestyle in subjects with impaired glucose tolerance [2–5]. Although intensive lifestyle intervention can result in significant improvements in a range of clinical and metabolic variables, the efficacy of dietary components on predicting improvements in glucose disturbances remains to be determined and the role of fatty acids on the course of glucose homeostasis in prediabetic individuals continues to be unclear.

Modern agriculture and food industrialization have led to changes in the composition of the food supply in Western society, the amount of ω-6 fatty acids has increased and that of

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ω-3 fatty acids has decreased during human evolution, from 1:1 (ω-6:ω-3) to 10:1 or 20–25:1 [6]. In animal models, high ω-3 fatty acid intakes were able to completely reverse high saturated fat diet-induced insulin resistance [7]. In humans, these associations remain controversial. Beneficial effects of high ω-3 fatty acid diets on the incidence of type 2 diabetes have been reported [8,9], although not independent of other fat subtype intakes [10]. Intervention studies with ω-3 fatty acid supplements had no impact on insulin sensitivity in normoglycemic [11] and individuals with type 2 diabetes [12–14]. In a recent systematic review, the investigators concluded that the effect of dietary fat quality on insulin sensitivity remains unknown, given the unclear associations suggested by descriptive and controlled intervention studies [15].

One study conducted using a Japanese cohort showed that fish intake and ω-3 polyunsaturated fatty acid supplements were associated with 18% and 19% lower risks of mortality from cardiovascular diseases [16]. Moreover, in a cross-sectional study, very high levels of marine-derived fatty acids showed antiatherogenic properties in Japanese living in Japan [17]. Furthermore, the usual intake of foods rich in ω-3 fatty acids in Japan has been considered the cornerstone for the protection against cardiovascular diseases in this population [18].

Migration studies have suggested that the adoption of a Western lifestyle is strongly associated with the risk of developing type 2 diabetes. Since 1993, the Japanese-Brazilian Diabetes Study Group has conducted a population-based study of Japanese migrants and their descendents in Brazil, who have one of the highest prevalences of glucose metabolism disturbances worldwide [19], suggesting that the exposure to a different lifestyle may exacerbate an inherent tendency to accumulate fat and develop diabetes [20]. Previous analyses have reported that high intakes of total fat and saturated fatty acids are associated with peripheral arterial disease and the metabolic syndrome in Japanese Brazilians [21–23]. These findings have stimulated the development of a 2-y community-based lifestyle intervention program, as an attempt to prevent/reduce the risk of developing diabetes and its complications in Japanese Brazilians. The hypothesis of the present study was that changes in dietary intake could predict improvement in glucose metabolism. The relation between dietary fatty acids, especially ω-3 fatty acids and the ω-3:ω-6 ratio, to improvements in glucose tolerance status after a 12-mo lifestyle intervention was investigated in Japanese Brazilians at high risk of type 2 diabetes at baseline.

Materials and methods

The Japanese-Brazilian Diabetes Study was established to investigate the prevalence and incidence of diabetes and related diseases in a population of Japanese ancestry living in Bauru, São Paulo State, Brazil. Two cross-sectional studies were previously conducted in 1993 and 2000 [19]. In 2005, individuals older than 30 y, Japanese-born or Brazilian-born, not miscegenated, in the Japanese-Brazilian community were invited to take part in a 24-mo community-based, quasiexperimental, non-pharmacologic lifestyle intervention program aiming at the prevention and control of diabetes and related diseases. A complete baseline assessment on dietary intake and anthropometric and biochemical analyses was carried out in 644 Japanese Brazilians (57% women, 85% of second generation). Four hundred fifty-five individuals (71%) participated at the second nutritional and biochemical examination conducted after 12 mo of intervention. According to the World Health Organization guidelines [24], 166 (36%) showed normal glucose tolerance, 42 (9.2 %) impaired fasting glycemia (IFG), 114 (25%) impaired glucose tolerance (IGT), and 133 (29%) type 2 diabetes at baseline. Self-reported use of antidiabetic agents was considered a diagnosis of type 2 diabetes.

Given the evidence of the beneficial effects of a healthy lifestyle on the health profile and that Japanese Brazilians are at high risk for cardiovascular diseases, for ethical reasons, there was no control group and the entire community was invited to engage in the lifestyle intervention program. The ethics committee of the Federal University of São Paulo approved the study protocol, and written informed consent was obtained from all participants. The investigation was carried out in accordance with the principles of the Declaration of Helsinki. In the present analysis, 156 participants showing baseline disturbances of glucose metabolism (IGT or IFG) who attended the anthropometric, biochemical, and lifestyle assessments at baseline and after the 12-mo intervention period were included.

The intervention strategies emphasized a combination of changing behaviors of dietary intakes and physical activity patterns based on evidence of lifestyle protective effects on chronic diseases [1] and on a previous nutritional trial conducted in overweight Brazilian adults [25,26]. Briefly, subjects were scheduled for one individualized dietary counseling session and two group sessions during the first 12 mo of intervention. The lifestyle goals established were practice of at least 150 min of physical activity per week, the consumption 400 g of fruits and vegetables per day, intake of diets with less than 10% of energy from saturated fat, and 5% of weight reduction in overweight individuals. The participants had a face-to-face 1-h consultation with a nutritionist (60 d after the first assessment), when participants received a diet prescription with a food exchange list. In addition, they were scheduled for two 90-min group sessions (6 and 9 mo after the first assessment) conducted by the nutritionist and the physical activity trainer, in which the subjects were encouraged to make intermediate goals for themselves by thinking about practical things they could try to change (instead of an abstract goal such as ‘‘eat less saturated fat, increase fiber intake and energy expenditure,’’ the practical goals were ‘‘eat no more than two small portions of meat per day, choose fish instead at least two times per week,’’ ‘‘eat five portions of fruits/vegetables every day,’’ ‘‘practice at least 30 min of physical activity every day’’).