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Studies on association between carbohydrate and fat intake as exposure factors and the incidence risk of type 2 diabetes

(炭水化物と脂質の摂取に関する曝露因子と糖尿病発症との関連に関する研究)

[Background and purpose] To date, the number of diabetes cases worldwide have steadily increased. Among the dietary factors that affect diabetes, carbohydrate and fat are one of nutrients affect glucose metabolism. As the intake of carbohydrate and fat have changed widely over time, it is important to examine the association between carbohydrate and fat intake as exposure factor and the incidence risk of type 2 diabetes. Therefore, this study was: (i) to clarify an overview of the association between carbohydrate and fat intakes as exposure factors and incidence of type 2 diabetes: (Chapter 1). (ii) to clarify association between total fat, fatty acids and incidence of type 2 diabetes among Japanese (Chapter 2). (iii) to clarify association between low carbohydrate diet score and incidence of type 2 diabetes among Japanese (Chapter 3).

Chapter 1

[Methods 1] This review was performed in two steps, Step 1 and Step 2, in that order. Step 1 was conducted to search for the latest systematic review and meta-analysis to investigate the association of carbohydrate and fat intake as exposure factors with the incidence risk of type 2 diabetes using PubMed, and it extracted their data such as exposure factor, the number of studies in all countries and in Asia countries which adopted by the systematic review and meta-analysis, results of meta-analysis comparing highest versus lowest category in all countries and in Asia countries. Step 2 was collected data extraction from the original papers that adopted the systematic reviews and meta-analyses, searched in Step 1.

[Results 1] Three papers were extracted, and the exposure factors were carbohydrate, total fat, SFA, MUFA, PUFA, n-6 PUFA, n-3 PUFA, and “low carbohydrate diet score”. For carbohydrate, the number of studies included in the meta-analysis were 13 (Asia, 6). For fat, the number of studies were 8 (Asia, 2) for total fat, 11 (Asia, 1) for SFA, 9 (Asia, 1) for MUFA, 8 (Asia, 0) for PUFA, 6 (Asia, 1) for n-6 PUFA, and 12 (Asia, 3) for n-3 PUFA. For low carbohydrate diet score, the number of studies were 5 (Asia, 2). These three results of meta-analysis comparing highest versus lowest category found no significant association. For only carbohydrate, subgroup analysis conducted by geographical regions, and differences were observed (Asian: RR = 1.29, 95% CI 1.15, 1.45; non-Asian: RR = 0.92, 95% CI 0.83, 1.01).

[Discussion 1] This review revealed a shortage of studies in Asia regarding the association of total fat, fatty acids, and “low carbohydrate diet score” with the incidence risk of type 2 diabetes. Compared to non-Asians, Asians have a higher carbohydrate and lower fat intake in addition to lower insulin secretory capacity. Thus, association of carbohydrate and fat intake with the incidence risk of type 2 diabetes may differ Asians and non-Asians. Therefore, among Asians such as Japanese, further research is needed to investigate the relationship between fat, fatty acids, and low carbohydrate diet score and type 2 diabetes.

Chapter 2

[Methods 2] This study was conducted using JACC study data. A total of 19088 Japanese aged 40–79 years were included in this analysis. Dietary assessment was evaluated by a validated food-frequency questionnaire. The incidence of type 2 diabetes was assessed by a self-administered questionnaire about 5 years after baseline. Multivariable logistic regression analysis was used to estimate the OR and 95 % CI of incident type 2 diabetes across the quintiles of total fat, SFA, MUFA, PUFA, n-6 PUFA, and n-3 PUFA, with adjustment for potential confounders.

[Results 2] For men, the multivariable-adjusted OR of incident type 2 diabetes for the highest versus lowest quintiles was 0.58 (95% CI, 0.37, 0.90; p-trend = 0.037) for total fat, 0.78 (95% CI, 0.51, 1.21; p-trend = 0.120) for SFA, 0.55 (95% CI, 0.35, 0.86; p-trend = 0.019) for MUFA, 0.61 (95% CI, 0.39, 0.96; p-trend = 0.059) for PUFA, 0.64 (95% CI, 0.42, 0.99; p-trend = 0.111) for n-3 PUFA, and 0.70 (95% CI, 0.45, 1.09; p-trend = 0.115) for n-6 PUFA, indicating that total fat, MUFA, PUFA, and n-3 PUFA were inversely associated with type 2 diabetes. For women, total fat and fatty acid intake were not significantly associated with type 2 diabetes.

[Discussion 2] The results of this study indicated that total fat, MUFA, PUFA, and n-3 PUFA intakes were inversely associated with type 2 diabetes in Japanese men. In women, total fat and fatty acids intake were not significantly associated with type 2 diabetes. SFA and n-6 PUFA intake were not associated with type 2 diabetes in either sex. For total fat, MUFA, PUFA, and n-3 PUFA, although no significant associations with type 2 diabetes were found in the previous meta-analysis, which included many non-Asian countries, the present study found inverse association with type 2 diabetes in men in Japan. This difference in findings may be due to Asians, such as Japanese, having a lower fat intake than non-Asians.

Chapter 3

[Methods 3] This study was conducted using JACC study data. A total of 19084 Japanese participants aged 40–79 years were included in this analysis. Dietary assessment was evaluated by a validated food-frequency questionnaire. The overall, animal and vegetable low carbohydrate diet score were calculated by dividing the study participants into eleven categories based on the percentages of energy from carbohydrates, protein and fat. The incidence of type 2 diabetes was assessed by a self-administered questionnaire about 5 years after baseline. Multivariable logistic regression analysis was used to estimate the OR and 95 % CI of incidence type 2 diabetes across the quintiles of each low carbohydrate diet score, with adjustment for potential confounders.

[Results 3] The multivariable-adjusted OR of incidence type 2 diabetes for the highest versus lowest quintiles of the overall and animal low carbohydrate diet score, respectively, were 0.64 (95% CI 0.42, 0.99) and 0.83 (95% CI 0.55, 1.27) for men, 0.78 (95% CI 0.51, 1.18) and 0.84 (95% CI 0.57, 1.24) for women.

[Discussion 3] The present study found that the overall, and animal low carbohydrate diet scores were not associated with the risk of type 2 diabetes in both sexes. The present study did not find any evidence of a link between the higher three low carbohydrate diet scores and a higher risk of type 2 diabetes in both sexes. This contradicts the findings of previous studies in non-Asia. This difference in findings may be due to variations in insulin secretion capacity and % of energy from carbohydrates between Asia and non-Asia.

[Conclusions] Based on the review in chapter 1, among Asians such as Japanese, further research is needed to investigate the relationship between total fat, fatty acids, and a low carbohydrate diet score and type 2 diabetes. In chapter 2, among Japanese, higher intakes of total fat, MUFA, PUFA, and n-3 PUFA were inversely associated with type 2 diabetes among Japanese men. In chapter 3, among Japanese, overall, the animal low carbohydrate diet score was not associated with a higher incidence of type 2 diabetes in both sexes, while the vegetable low carbohydrate diet score was associated with a lower incidence in men. However, the follow-up year of the present study and previous studies in Asia were shorter than non-Asia. Therefore, further long-term follow-up cohort studies in Asia are necessary.