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Original Article

Relationship between Glycemic Load and Blood Lipid Level in Hospitalized Adult Chinese

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Abstract

Background: Metabolic diseases in China have been on the rise in recent decades, partially due to reduced cereal consumption and excessive intake of low glycemic index (GI) foods such as meat and oil. Although the relationship between dietary glycemic load (GL) and various metabolic diseases has been extensively studied worldwide, it is unclear whether dietary GL is related to blood lipid levels and dyslipidemia risk in Chinese. The aim of the present study was to investigate the relationship between dietary GL and blood lipid levels and dyslipidemia risk in hospitalized Chinese adults.

Methods: Dietary GL in 2258 hospitalized Chinese adults was calculated based upon GI, carbohydrate content and daily intake of individual foods. In addition, fasting total cholesterol (TC), triglycerides (TG), HDL cholesterol (HDL-C) and LDL cholesterol (LDL-C) data were collected. Multiple regression and logistic regression analysis were used to determine the relationship between dietary GL and plasma lipid levels or dyslipidemia risk.

Results: Dietary GL remained inversely associated with blood total cholesterol (TC) and low-density lipoprotein cholesterol (LDL-C) ($P<0.01$). With increasing dietary GL, risks of hypercholesterolemia and high blood LDL-C were significantly reduced ($P<0.01$). In the meantime dietary GL remained negatively associated with blood triglyceride (TG) and high-density lipoprotein cholesterol (HDL-C) ($P<0.01$), but showed no significant influence on risk of hypertriglyceridemia and low blood HDL-C ($P>0.05$).

Conclusion: High GL diet, as represented by traditional Chinese dietary pattern, may contribute to reduced risk of dyslipidemia in Chinese adults.

Keywords: Glycemic load, Blood lipid, Carbohydrate, Dyslipidemia, Adult, China

Introduction

Diet carbohydrates are critically important to the health of human body. In 1997, Walter Willett and his colleagues proposed the concept of dietary glycemic load (GL), used to reflect the quality and quantity of dietary carbohydrates (1). Since then, many studies have been performed to determine the potential physiological impact of GL on blood lipid level and dyslipidemia risk, although with inconsistent conclusions. In 2002, a national survey on nutrition and health status in Chinese showed that people with low dietary GL tended to consume more fats and less cereal. The incidence of overweight and obesity was higher in people with low dietary GL than those with high GL were (2). In contrast, several studies conducted in western people have shown that a high dietary glycemic load or glycemic index (GI) is associated with elevated risks of metabolic syndromes and cardiovascular disease (CVD) (3-6). A possible explanation to this discrepancy is the difference in dietary patterns between Chinese and western people (7).

Growing number of Chinese are suffering from dyslipidemia, which is closely related to a violation of the dietary guideline of "diversified foods with sufficient cereal and moderate quantity of animal foods" for Chinese citizens published by the Chinese Society of Nutrition in 2002 (8, 9). Nevertheless, large number of studies is required to clarify the causal dietary factors in dyslipidemia.

In the current study, we seek to investigate the relationship between dietary carbohydrates and blood lipid levels or dyslipidemia risk in hospitalized Chinese adults, by using dietary GL as an indicator of carbohydrates. Our study results thus provide helpful information towards a more rational dietary pattern in peoples from developing countries like China.

Methods

Subjects

A total of 2258 Chinese adults hospitalized in the General Hospital of Chinese People's Armed Police Forces from January 2012 through May 2013 were consecutively selected. Patients with severe cardiac, hepatic or renal impairments and those not able to eat orally were excluded. Patients who were fasting or those on strictly limited diet on days 1-3 of hospitalization were also excluded. The participation rate was 85.9% and 319 patients were excluded. The average age of all the 2258 selected patients (1267 male and 991 female) was 52 (range 19-69) years.

This study was conducted in accordance with the Declaration of Helsinki and all procedures were approved by the Ethics Committee of the General Hospital of Chinese People's Armed Police Forces. Written informed consent for the use of personal medical data was obtained from all patients selected. GI data were from Food Composition Table of China (2004) and International GI Table (10, 11).

Data analysis

Dietary GL/day was calculated according to dietary GI and daily consumption of various foods. Daily dietary GL=Σ (food GI × daily quantity of carbohydrates obtained from that food). In order to compare blood lipid at the same level of total energy intake, daily energy intakes in all patients in the current study were adjusted to 10460kJ/day as previously described (12). In this manuscript, GL in the Abstract, Results and Discussion represents glycemic load corrected to 10460kJ (GL/10460kJ).

Baseline measurements

In all selected patients, food intake was recorded on days 1-3 of hospitalization and average nutrient intake was calculated. During hospitalization, patients ordered foods on their own from nutrition canteen in our hospital. Therefore, all foods (including fruits and snacks, weighed as precisely as 0.1g) for all the enrolled patients were provided by the hospital. In order to guarantee the accuracy of food weighing, residual foods that were not eaten by patients were recovered and quantified. Body mass and height for each patient were determined by nurses in charge according to one uniform criterion. Weight was measured without shoes and in light clothes to the nearest 0.1 kg by using a beam balance scale. Height was measured to the nearest 0.1 cm by using a stadiometer.

Blood collection and assessment of biomarkers

Peripheral blood samples were collected before breakfast in the morning on day 1 of hospitalization. Fasting (at least 10 hours) total cholesterol, triglycerides, HDL and LDL cholesterol were determined.

Diagnosis of dyslipidemia

According to the diagnostic criteria published by the Chinese adult dyslipidemia Prevention Guide: hypercholesterolemia is defined as fasting total cholesterol concentration ≥ 5.18 mmol/l; hypertriglyceridemi-a is defined as fasting total triglycerides concentration ≥ 1.7 mmol/l; hypo-HDL-C is defined as HDL cholesterol concentration ≤ 1.04 mmol/l; and hyper-LDL-C is defined as LDL cholesterol concentration ≥ 3.37 mmol/l (13).

Statistical analysis

Mean TC, TG, HDL and LDL cholesterol were calculated by quartiles of dietary GL. ANOVA analysis was used to determine the existence of differences in the above parameters among all GL quartiles. Multiple regression and logistic regression were used to analyze the relationship between dietary GL and blood lipid levels or dyslipidemia risk. Statistical package SPSS for Windows, version 19.0 (SPSS Inc, Chicago, III), was used for statistical analysis. A *P* value of <0.05 was considered statistically significant.

Results

General information of all the 2258 patients was shown in Table 1. Mean dietary GL was nearly 2-folds in the highest quartile as that of the lowest quartile of the study population. Patients with high GL consumed more carbohydrates and fewer fats than did patients with low GL.Multiple regression analysis was used to determine the possible correlation between dietary GL and various blood lipid levels. As shown in Table 2, dietary GL was negatively associated with TC, TG, HDL and LDL cholesterol (*P*<0.01).

Table 1: Characteristics of participants by quartiles of dietary GL

	Quartiles of dietary GL				*p*
	<P25	P25-P50	P50-P75	>P75	
Age (yr)					
All	51.6±8.7	53.1±10.2	52.7±8.9	52.3±8.3	0.0065
Male	49.4±7.2	51.1±7.9	50.4±7.5	50.3±7.7	0.0037
Female	53.7±11.2	54.2±11.5	53.9±11.0	54.0±12.7	0.03
Wt(kg)	68.3±14.2	67.9±13.5	67.7±13.9	66.9±12.8	0.17
BMI	23.6±3.2	24.5±3.7	24.9±3.9	24.2±3.3	0.29
Waist Circumference (cm)	88.5±18.2	84.3±17.0	82.9±16.3	79.1±15.2	0.00058
Dietary GL	187.3±56.7	232.1±67.5	278.8±79.0	324.2±91.2	0.0021
Cereal intake (g/d)	195.1±53.8	283.7±76.7	330.1±87.9	405.2±96.5	0.0046
Fat intake (g/d)	129.3±35.7	97.1±28.2	77.9±16.9	64.0±11.7	0.0087
TC(mmol/l)	5.94±1.38	5.61±1.19	5.02±1.26	4.72±0.97	0.0053
TG(mmol/l)	1.93±0.35	1.75±0.31	1.47±0.27	1.32±0.22	0.00090
HDL-C(mmol/l)	1.51±0.43	1.43±0.37	1.29±0.33	1.17±0.28	0.00076
LDL-C(mmol/l)	3.16±0.76	2.77±067	2.62±0.62	2.34±0.59	0.0031

Table 2: Multiple regression analysis of dietary GL and blood lipid level Dietary GL

	Independent variable (mmol/L)			
	TC	TG	HDL-C	LDL-C
β	−0.0734	−0.0572	−0.0349	−0.0630
P	0.00024	0.00038	0.0076	0.0000023

*adjusted for age, gender, body mass index, energy intake, fat intake and cereal intake.

In patients in various GL quartiles, there were significant differences in the incidences of hypercholesterolemia, hypertriglyceridemia, hypo-HDL-C and hyper-LDL-C (Table 3). Results of logistic regression analysis showed that with increasing daily dietary GL, risks of hypercholesterolemia and high LDL-C were significantly reduced (*P*<0.05), whereas risk of neither hypertriglyceridemia nor low HDL-C was significantly altered(*P*>0.05) (Table 4).

Table 3: Dyslipidemia rate in hospitalized patients within different dietary GL quartiles (%)

	<P25	**P25-P50**	**P50-P75**	**>P75**	***P***
Hypercholesterolemia	7.67	6.58	5.91	5.15	0.000016
Hypertriglyceridemia	15.63	14.12	13.71	12.40	0.000025
Hypo-HDL-C	4.17	4.63	4.99	5.53	0.0093
Hyper-LDL-C	9.81	8.14	7.12	6.91	0.000041

Table 4: Logistic regression analysis on dyslipidemia risk and dietary GL

	<P25	**P25-P50**	**P50-P75**	**>P75**	***P***
Hypercholesterolemia	1.00	0.774	0.673	0.514	0.0010
Hypertriglyceridemia	1.00	0.972	0.953	0.917	0.28
Hypo-HDL-C	1.00	1.025	1.031	1.043	0.15
Hyper-LDL-C	1.00	0.724	0.612	0.538	<0.0032

*adjusted for age, gender, body mass index

Discussion

Rational diet depends on balanced energy composition of carbohydrates, fats and proteins. Conventionally, Chinese dietary pattern is composed of a high-energy ratio of carbohydrates and relatively low energy ratios of proteins and fats. However, incidences of various metabolic diseases in China have been on the rise, partially due to altered dietary patterns that took place in the past decades (2, 7). In the current study, we showed that total cholesterol concentration was negatively related to dietary GL in hospitalized Chinese patients. With increasing dietary GL, risk of hypercholesterolemia was decreased. Our study results are supported by data from the Chinese nutrition and health survey in 2002 in which energy composition of carbohydrates was inversely related to total cholesterol: In comparison to people in whom ＜55% calorie was provided by carbohydrates, those with carbohydrate-derived calorie of 55%~65% and ≥65% had 18% and 31% reduced incidence of hypercholesterolemia, respectively (14). We also showed in our previous study that patients with lower dietary GL had higher incidences of overweight, obesity and metabolic syndrome than those with higher dietary GL (12). A low-fat and high-carbohydrate diet is associated with significantly decreased blood pressure and total cholesterol, as well as significantly increased HDL-C in overweight people (15). In a 6-month prospective study, a low-fat and high-carbohydrate diet resulted in a significant reduction of weight and fat mass, whereas preserved lean body mass in obese subjects (16).

As typical lipoprotein dysregulations that are associated with metabolic syndromes, high TG and low HDL-C are independent risk factors for CVD (17, 18). To date, studies on the relationship between dietary GL and TG/ HDL-C have come to controversial conclusions. In our current study, a negative correlation between dietary GL and triglycerides was observed. And the incidence of hypertriglyceridemia was higher in low GL groups than that in high GL group, although logistic regession analysis showed no significant impact of dietary GL on hypertriglyceridemia risk. Our findings are consistent with some clinical and cross-sectional studies, which have showed an inverse association between dietary GL and HDL-C or TG concentration (19-22). We also observed a negative association between dietary GL and

LDL-C. It is possible that decreased dietary fat, which may inadvertently result in increased intake of dietary carbohydrate and hence increased GL, leads to a reduction in LDL-C (23). HDL-C and LDL-C play opposite roles in the progress of CVD. In this study, however, HDL-C and LDL-C showed consistent correlation with dietary GL for unclear reasons. Further studies are required to elucidate the mechanisms through which HDL-C and LDL-C are influenced by dietary GL.

Results in our study are not conflicting with low GI diet that is recommended. GI reflects the quality of carbohydrates in a single food, which is independent of total carbohydrate intake. In contrast to GI, dietary GL reflects both the quality and quantity of dietary carbohydrates. For this reason, high dietary GL definitely does not mean high GI foods. Moreover, the specific food categories should be considered when low GI foods are recommended. For example, whole cereals are recommended, as their GI is lower than that of refined cereals, while excessive animal foods including meats and animal oils are not recommended even though their GI is much lower than that of whole cereals. Carbohydrates are the major energy source in Chinese that provide around 50% of daily energy intake on average (14). Our study results argue for that rational diet for Chinese underscores reduced fat intake and increased quantity of carbohydrates to a suitable level. Meanwhile, low GI carbohydrates are particularly recommended as they help to reduce CVD incidence.

Quite a number of studies outside China demonstrated correlation between high GL diet and dyslipidemia, in which high GL diet served as a risk factor for CVD (24, 25). However, it is notable that race (gene) is also an important factor that may influence lipid and glucose metabolism at a given GL level (26, 27). The thrifty gene hypothesis theorizes that during evolution a set of genes has been selected to ensure survival in environments with limited food supply. It has been proposed that in peoples who experienced poverty during a period, the body will easily store energy as fats. These individuals are more prone to metabolic diseases including diabetes when food supply became more than sufficient in a short period of time (28). For this reason, we speculate the discrepancy in study results in our current study and those in western people might result from the differences between peoples and dietary patterns. In addition, dietary GL in those studies were measured by using dietary recall method and food-frequency questionnaires, which may cause exposure misclassification and thus biased conclusions. Moreover, the assessment of medical history in those studies was based on self-report, which was inherently less reliable than clinical measurement. In this study, we used a unified method to quantify foods, which we believe would reduce errors in determining food quantity and quality.

It should be pointed out that patients in this study were eating hospital foods during dietary data collection, which may cause data deviation from their regular and long-term daily diets. Another critical issue is that blood lipid levels can also be influenced by various underlying diseases in addition to long-term diet. Thus, the conclusions in this study should be interpreted with caution and confirmed by independent studies in the future.

Conclusion

Relative high GL diet is associated with reduced incidence dyslipidemia in Chinese. We conclude that traditional Chinese dietary pattern, which is characterized by relative high fraction of carbohydrate-derived calorie and low fraction of fat-derived calorie, helps to prevent dyslipidemia. The impact of traditional Chinese dietary pattern on metabolic diseases warrants further investigation.

Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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