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Letter to the Editor

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Which Nutritional Factors Are Good for HDL?

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To the Editor

High-density lipoprotein (HDL) is a lipoprotein which has anti-atherogenic property by reversing cholesterol transport from the peripheral tissues to liver. Low HDL-cholesterol (HDL-C) as well as high LDL-C is associated with the development of coronary heart diseases [1, 2]. Low HDL-C is commonly observed in patients with insulin resistance, obesity and type 2 diabetes. In our previous study [3], serum HDL-C in type 2 diabetes [4], especially in type 2 diabetic patients with obesity [5], was lower than young lean men [6] and low Framingham risk score subjects [7] (Fig. 1), suggesting a significant influence of obesity, type 2 diabetes and insulin resistance on serum HDL-C levels.

Abnormal lipid metabolism induced by obesity, insulin resistance and type 2 diabetes was shown in Figure 2. Insulin resistance increases activity and expression of hormone-sensitive lipase (HSL) in adipose tissue, which catalyzes the breakdown of triglyceride (TG), releasing free fatty acids (FFAs) (Fig. 2) [8]. Increased FFA entry to liver elevates hepatic production of very low-density lipoprotein (VLDL) which is a TG-rich lipoprotein. Insulin resistance also decreases the activity of lipoprotein lipase (LPL), the rate-limiting enzyme of the catabolism of TG-rich lipoproteins such as VLDL [9]. The formation of HDL is related with the catabolism of TG-rich lipoproteins by LPL [10]. Therefore, reduced LPL activity increases VLDL and reduces HDL.

Insulin resistance is associated with diminished LDL-receptor (LDL-R) [11], and intestinal mRNA expression of Niemann-Pick C1-like 1 (NPC1L1) protein is increased in diabetes [12], suggesting that insulin resistance and diabetes may increase serum LDL-C by reducing clearance and enhancing cholesterol absorption.

The dietary and nutritional factors could influence on HDL metabolism. To make "Dietary Reference Intake for Japanese 2020 (for low HDL-C)", we searched meta-analyses of randomized controlled trials (RCTs) which investigated effects of energy and carbohydrate intake [13], glycemic index and intake of dietary fiber [14], intake of soy and non-soy legume [15] and consumption of various fatty acids [16], on serum HDL-C levels. Seen in Figure 2, since low HDL-C is likely to accompany with obesity, insulin resistance and high TG. Elevation of LDL-C can accompany with low HDL-C; moreover, atherogenic properties of LDL such as small dense LDL, oxidized LDL and glycated LDL are observed in type 2 diabetes [17]. Therefore, we investigated effects of nutritional factors on metabolic parameters other than HDL-C such as LDL-C, TG, body weight and waist circumference.

The summary of effects of nutritional factors on HDL-C and other metabolic parameters was shown in Table 1. Low carbohydrate diet increased HDL-C and decreased TG, however, increased LDL-C. Dietary fiber consumption did not affect HDL-C and TG, however, reduced LDL-C. Soy consumption increased HDL-C and deceased both TG and LDL-C. Saturated fatty acid consumption increased HDL-C, however, also increased LDL-C. Industrially produced trans fatty acid consumption reduced HDL-C and increased LDL-C.

When we consider effects of nutritional factors on HDL-C to prevent atherosclerosis, we should think about effects of nutritional factors on other lipids, especially LDL-C.

Conflict of Interest

The authors declare that they have no conflict of interest concerning this article.

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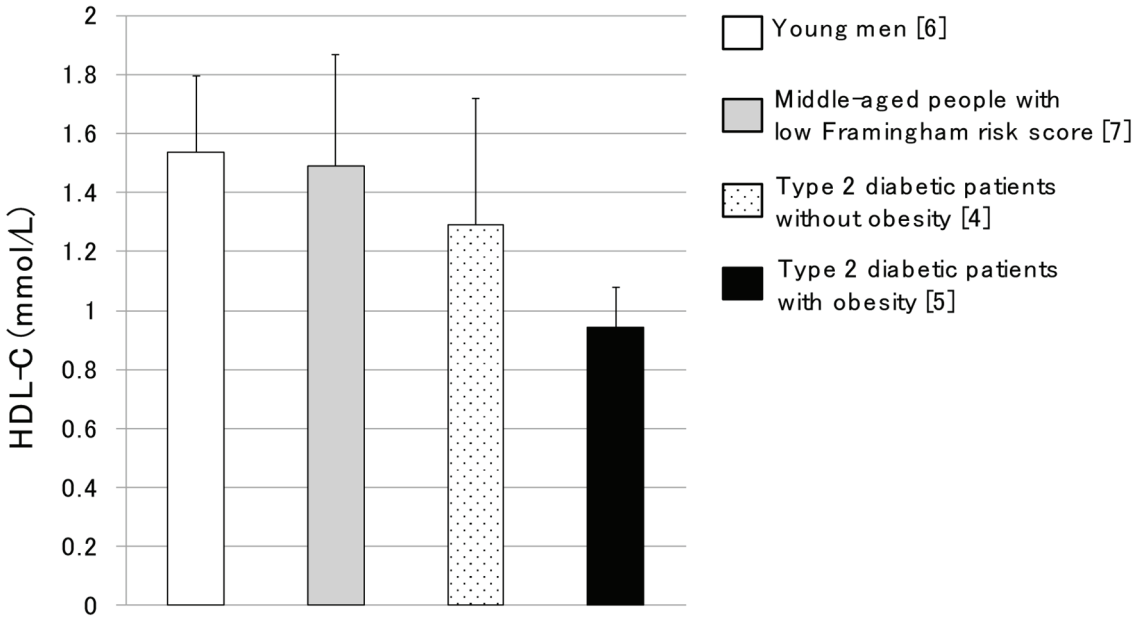

Figure 1. Serum HDL-C levels in young men, middle-aged people with low Framingham risk score, type 2 diabetic patients without obesity and type 2 diabetic patients with obesity. This figure was made by modification of data in our previous report [3].

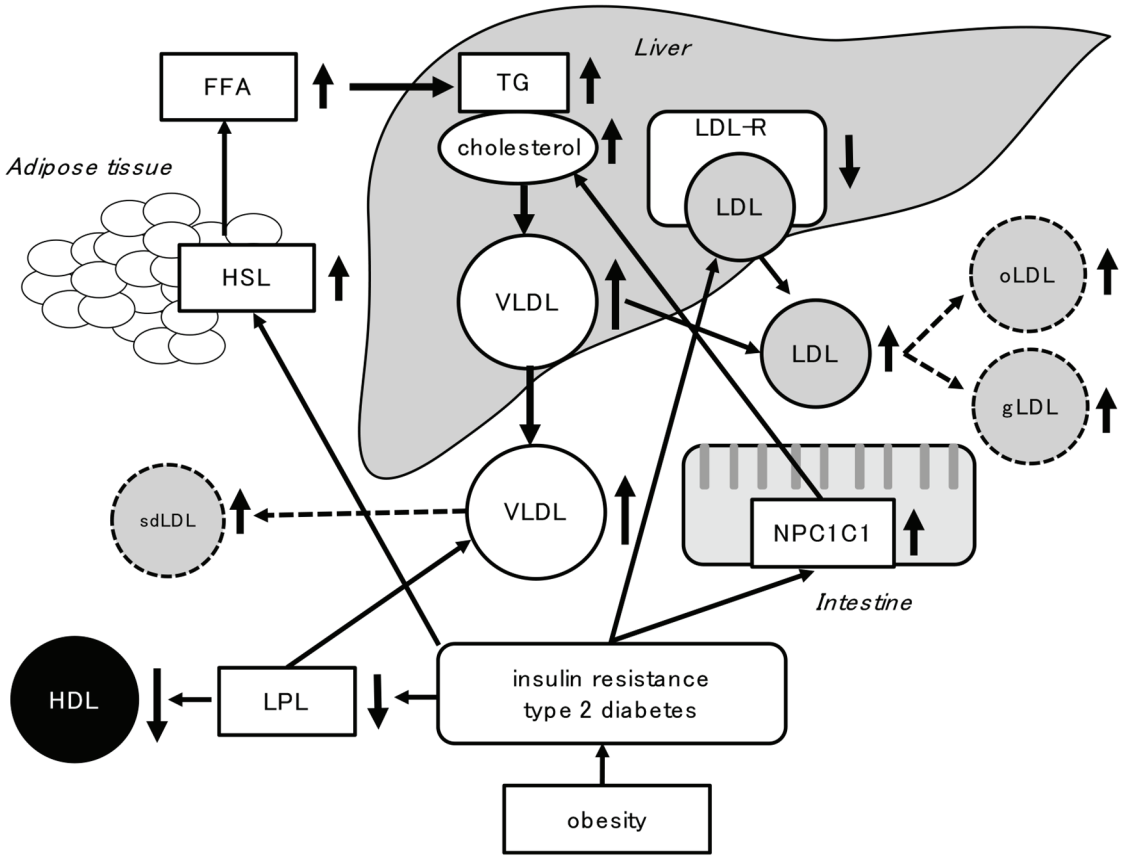

Figure 2. Abnormal lipid metabolism induced by obesity, insulin resistance and type 2 diabetes. FFA: free fatty acid; gLDL: glycated LDL: HSL: hormone-sensitive lipase; LDL-R: LDL-receptor; LPL: lipoprotein lipase; NPC1L1: Niemann-Pick C1-like 1; oLDL: oxidized LDL; sdLDL: small dense LDL; VLDL: very low-density lipoprotein.

Table 1. Effects of Nutritional Factors on HDL-C and Other Metabolic Parameters

	HDL-C	LDL-C	TG	BW, BMI, WC
Carbohydrate consumption				
Low LC diets (versus LF diets)	↑	↑	↓	↓
Low LC diets	↑	→	↓	↓ or →
Low GI diets	↑ or →	↓ or →	↓ or →	BW → or BMI → or WC →
Free sugars	↑	↑	↑	→
Fructose (hypercaloric)	→		↑	
Fructose (isocaloric)	→	→ or ↑	→	
Dietary fiber consumption				
Konjac glucomannan		↓		
Beta-glucan	→	↓	→	
Increased dietary fiber intake	↑ or →	↓	→	
Whole-grain foods	→	↓	↓	
Polyglycoplex	→	↓	→	BW →
Barley	→	↓	↓	
Psyllium	↓	↓	→	
Soy and non-soy legume consumption				
Soy	↑	↓	↓	
Soy products	↑	↓	↓	
Soy protein	↑	↓	↓	
Fatty acids consumption				
SFA	↑	↑		
Industrially produced-TFA	↓	↑		
Ruminant-TFA	→	→		
CLA	→	↓	→	
n-3 PUFA	→ or ↑	→ or ↓	↓	WC ↓ BMI →
MUFA	→ or ↑	↓ or →	→ or ↓	BW ↓ or BMI →

BMI: body mass index; BW: body weight; CLA: conjugated linoleic acid; GI: glycemic index; HDL-C: high-density lipoprotein-cholesterol; LC: low carbohydrate; LDL-C: low-density lipoprotein-cholesterol; LF: low fat; MUFA: mono-unsaturated fatty acid; PUFA: poly-unsaturated fatty acid; SFA: saturated fatty acid; TFA: trans fatty acid; TG: triglyceride; WC: waist circumference.

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