Effects of Glycemic Index and Intake of Dietary Fiber on Serum HDL-Cholesterol Levels

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Abstract

We previously studied effects of glycemic index (GI) and intake of dietary fiber on serum high-density lipoprotein (HDL)-C levels to make “Dietary Reference Intakes for Japanese 2015”, using data obtained by clinical trials which evaluated effects of GI and intake of dietary fiber on HDL-C in Asian populations. We found that low GI and an increased intake of dietary fiber may be beneficially associated with HDL metabolism. Here we review meta-analyses on the effects of GI and intake of dietary fiber on serum HDL-C levels, to make “Dietary Reference Intake for Japanese 2020”.

Keywords: Body weight; Dietary fiber; Glycemic index; High-density lipoprotein

Introduction

High-density lipoprotein (HDL) plays a role in reverse cholesterol transport from the peripheral tissues to liver, suppressing cholesterol accumulation in the peripheral tissue. Therefore, serum low HDL-cholesterol (HDL-C) level was strongly associated with development of atherosclerotic diseases [1, 2].

We previously studied effects of glycemic index (GI) and intake of dietary fiber on serum HDL-C levels to make “Dietary Reference Intakes for Japanese 2015”, using data obtained by clinical trials which evaluated effects of GI and intake of dietary fiber on HDL-C in Asian populations [3]. We found that low GI and an increased intake of dietary fiber may be beneficially associated with HDL metabolism [3]. Here we review meta-analyses on the effects of GI and intake of dietary fiber on serum HDL-C levels, to make “Dietary Reference Intake for Japanese 2020”.

Methods

To make “Dietary Reference Intake for Japanese 2020”, we searched meta-analyses of randomized controlled trials (RCTs). A search was conducted by using PubMed, Embase and Google Scholar, with the following keywords: glycemic index and HDL and meta-analysis or dietary fiber and HDL and meta-analysis. The search period was comprised up to May 2018.

Results

Effects of GI on HDL-C

Meta-analyses evaluated effects of GI on HDL-C were shown in Table 1. We found five meta-analyses which studied effects of GI on HDL-C [4-8]. All meta-analyses denied a significant effect of GI on HDL-C. However, three meta-analyses showed that compared with high GI, low GI reduced total cholesterol (TC) and low-density lipoprotein (LDL)-C [5-7]. Only one meta-analysis showed that low GI significantly reduced triglyceride (TG) [4]; however, other four studies challenged a significant effect of low GI on TG.

Effects of dietary fiber intake on HDL-C

Meta-analyses evaluated effects of dietary fiber intake on HDL-C were shown in Table 2. Eleven meta-analyses were eligible. In three meta-analyses, data on effects of dietary fiber intake on HDL-C were not available [9-11]. Seven meta-analyses reported that intake of dietary fiber is not significantly associated with changes in HDL-C. Two meta-analyses described that HDL-C was significantly reduced, but only by a small amount [12, 18].

Regarding other serum lipids, all meta-analyses demonstrated a significant reduction of LDL-C due to dietary fiber intake [9-19]. Three meta-analyses showed a significant reduc-
risk factors in healthy Japanese women (n = 1,354), dietary GI on the association between dietary GI and GL and metabolic outcomes was assessed. In the cross-sectional study available carbohydrate, in Korean men as compared with the highest quintile was 1.54 (CI: 1.17 - 2.03) for glycemic load (GL) which is calculated indirectly as GI times the weight of available carbohydrate, in Korean men as compared with the respective high GI counterparts. To make "Dietary Reference Intakes for Japanese 2015", we mainly adopted clinical studies performed in Japanese or Asian populations. Regarding effects of GI on HDL-C, we adopted and used three cross-sectional studies performed in Korea and Japan. This study investigated the correlation between dietary GI, GL and cardiovascular risk factors in 32 Japanese women aged 52.5 ± 7.2 years old, the highest concentration of HDL-C was observed in the lowest GI tertile (P < 0.01), and the highest concentration of HDL-C was observed in the lowest GL tertile (P < 0.01). In the cross-sectional study on the association between dietary GI and GL and metabolic risk factors in healthy Japanese women (n = 1,354), dietary GL was independently negatively correlated with HDL-C [21].

### Discussion

To make "Dietary Reference Intakes for Japanese 2020", we mainly adopted meta-analyses which have high evidence level. In spite of the existence of a significant association between low GI and reduction of LDL-C, meta-analyses reported that dietary fiber intake reduced serum lipid levels [13, 17]; however, six studies challenged a significant influence of dietary fiber intake on serum TG levels [12, 14-16, 19].

### Table 1. Meta-Analyses Evaluated Effects of Glycemic Index on HDL-C

<table>
<thead>
<tr>
<th>Authors</th>
<th>Assessed studies</th>
<th>Subjects studied</th>
<th>Effects on HDL-C</th>
<th>Effects on other lipids</th>
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<tbody>
<tr>
<td>Schwingshackl L, et al [4]</td>
<td>Meta-analyses were performed for each parameter to assess pooled effect in terms of WMD between the post-intervention of the low GI diets and the respective high GI counterparts</td>
<td>9 studies enrolling 1065 children or adolescents</td>
<td>HDL-C under investigation was not affected by either low or high GI</td>
<td>Compared to diets providing a high GI, low GI protocols resulted in significantly more pronounced decreases in serum TG (-15.14 mg/dL, 95% CI: -26.26 to -4.00)</td>
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<tr>
<td>Fleming P, et al [5]</td>
<td>RCTs on the effect of low-GI diets on serum lipid levels</td>
<td>4 studies</td>
<td>There was no significant effect on HDL-C levels</td>
<td>Low-GI diets were shown to have a significant effect on decreasing TC and LDL-C over a short time span (5 - 12 weeks). There was no significant effect on TG levels</td>
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<tr>
<td>Goff LM, et al [6]</td>
<td>RCTs comparing low- with high GI diets over at least 4 weeks</td>
<td>28 RCTs (1,272 participants; studies ranged from 6 to 155 participants)</td>
<td>There was no effect on HDL-C (MD: -0.03 mmol/L, 95% CI: -0.06 - 0.00)</td>
<td>Low GI diets significantly reduced TC (-0.13 mmol/L, 95% CI: -0.22 to -0.04, P = 0.004) and LDL-C (-0.16 mmol/L, 95% CI: -0.24 to -0.08, P &lt; 0.0001) compared with high GI diets independently of weight loss. There was no effect on TG (MD 0.01 mmol/L, 95% CI: -0.06 to 0.08)</td>
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<tr>
<td>Kelly S, et al [7]</td>
<td>RCTs that assess the relationship between the consumption of low GI diets over a minimum of 4 weeks and the effects on coronary heart disease and on risk factors for coronary heart disease</td>
<td>15 RCTs</td>
<td>There is no evidence that low GI diets have an effect on HDL-C</td>
<td>Meta-analysis detected limited and weak evidence of a relationship between low GI diets and slightly lower TC, compared with higher GI diets. There is no evidence that low GI diets have an effect on LDL-C and TG</td>
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<tr>
<td>Opperman AM, et al [8]</td>
<td>RCTs with a crossover or parallel design, investigating the effect of low GI versus high GI diets on markers for carbohydrate and lipid metabolism</td>
<td>16 studies (10 crossover design and 6 parallel design, n = 396)</td>
<td>No change was observed in HDL-C</td>
<td>Low GI diets significantly reduced TC by -0.33 (95% CI: -0.47 to -0.18) mmol/L (P &lt; 0.0001) and tended to reduce LDL-C in type 2 diabetic subjects by -0.15 (95% CI: -0.31 to -0.00) mmol/L (P = 0.06) compared with high GI diets. No change was observed in TG</td>
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CI, confidence interval; GI, glycemic index; HDL-C, high-density lipoprotein-cholesterol; LDL-C, low-density-cholesterol; MD, mean difference; RCT, randomized controlled trial; TC, total cholesterol; TG, triglyceride; WMD, weighted mean difference.
Table 2. Meta-Analyses Evaluated Effects of Dietary Fiber Intake on HDL-C

<table>
<thead>
<tr>
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<th>Subjects studied</th>
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<tbody>
<tr>
<td>Ho HVT, et al [9]</td>
<td>RCTs with a follow-up of ≥ 3 weeks that assessed the effect of konjac glucomannan (KJM) on LDL-C, non-HDL-C or apolipoprotein B</td>
<td>12 studies (n = 370), 8 in adults and 4 in children</td>
<td>NA</td>
<td>KJM significantly lowered LDL-C (MD: -0.35 mmol/L; 95% CI: -0.46 to -0.25 mmol/L) and non-HDL-C (MD: -0.32 mmol/L; 95% CI: -0.46 to -0.19 mmol/L). Data from six trials suggested no impact of KJM on apolipoprotein B</td>
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<tr>
<td>Ho HV, et al [10]</td>
<td>RCTs of ≥ 3-week duration assessing the effect of diets enriched with barley β-glucan compared with controlled diets on LDL-C, non-HDL-C or apoB</td>
<td>14 trials (n = 615)</td>
<td>NA</td>
<td>A median dose of 6.5 and 6.9 g/day of barley β-glucan for a median duration of 4 weeks significantly reduced LDL-C (MD: -0.25 mmol/L (95% CI: -0.30 to -0.20)) and non-HDL-C (MD: -0.31 mmol/L (95% CI: -0.39 to -0.23)), respectively, with no significant changes to apoB levels, compared with control diets</td>
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<tr>
<td>Ho HV, et al [11]</td>
<td>RCTs investigating the cholesterol-lowering potential of oat β-glucan on LDL-C, non-HDL-C and apoB</td>
<td>58 trials (n = 3,974)</td>
<td>NA</td>
<td>A median dose of 3.5 g/day of oat β-glucan significantly lowered LDL-C (-0.19; 95% CI: -0.23 to -0.14 mmol/L, P &lt; 0.00001), non-HDL-C (-0.20; 95% CI: -0.26 to -0.15 mmol/L, P &lt; 0.00001) and apoB (-0.03; 95% CI: -0.05 to -0.02 g/L, P &lt; 0.0001) compared with control interventions</td>
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<td>Hartley L, et al [12]</td>
<td>RCTs that assessed the effects of dietary fiber compared with no intervention or a minimal intervention on CVD and related risk factors</td>
<td>23 RCTs (1,513 participants)</td>
<td>There was a very small but statistically significant decrease rather than increase in HDL-C with increased fiber intake (MD: -0.03 mmol/L, 95% CI: -0.06 to -0.01)</td>
<td>There is a significant beneficial effect of increased fiber on TC (MD: -0.23 mmol/L, 95% CI: -0.40 to -0.06), and LDL-C (MD: -0.14 mmol/L, 95% CI: -0.22 to -0.06) but not on TG (MD: 0.00 mmol/L, 95% CI: -0.04 to -0.05)</td>
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<tr>
<td>Hollænder PL, et al [13]</td>
<td>RCTs compared whole-grain foods with a non-whole-grain control in adults</td>
<td>6,069 articles</td>
<td>No effect of whole-grain foods on HDL-C was seen</td>
<td>Whole-grain intake lowered LDL-C (WMD: -0.09 mmol/L; 95% CI: -0.15 to -0.03 mmol/L; P &lt; 0.01) and TC (WMD: -0.12 mmol/L; 95% CI: -0.19 to -0.05 mmol/L; P &lt; 0.001) compared with the control. Whole-grain foods tended to lower TG compared with the control (WMD: -0.04 mmol/L; 95% CI: -0.08 - 0.01 mmol/L; P = 0.10)</td>
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<tr>
<td>Zhu X, et al [14]</td>
<td>RCTs that investigated the effects of beta-glucan consumption in hypercholesterolemic subjects</td>
<td>17 eligible RCTs with 916 subjects</td>
<td>There were no significant differences in HDL-C</td>
<td>Beta-glucan consumption in hypercholesterolemic population significantly lowered TC (MD: -0.26 mmol/L; 95% CI: -0.33 to -0.18; P &lt; 0.00001) and LDL-C (MD: -0.21 mmol/L; 95% CI: -0.27 to -0.14; P &lt; 0.00001). There were no significant differences in TG</td>
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<td>Onakpoya IJ, et al [15]</td>
<td>RCTs examining the effectiveness of polyglycoplex (PGX), a novel functional fiber, on body weight and metabolic parameters</td>
<td>4 RCTs with a total of 217 participants</td>
<td>There was no significant difference between PGX and placebo for HDL-C</td>
<td>Significant reductions were noted for TC and LDL-C. There was no significant difference between PGX and placebo for TG</td>
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<tr>
<td>Whitehead A, et al [16]</td>
<td>RCTs comparing ≥ 3 g oat β-glucan (OBG)/d with an appropriate control.</td>
<td>28 RCTs</td>
<td>There was no significant effect of OBG on HDL-C</td>
<td>OBG in doses of ≥ 3 g/day reduced LDL-C and TC relative to control by 0.25 mmol/L (95% CI: 0.20 - 0.30; P &lt; 0.0001) and 0.30 mmol/L (95% CI: 0.24 - 0.35; P &lt; 0.0001), respectively. There was no significant effect of OBG on TG</td>
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</table>
et al performed a RCT to examine the effects of a soluble fiber and a potassium-rich diet containing daily 0.5 - 1.0 kg of guava intake in patients with essential hypertension [24]. In their study, increased intake of soluble dietary fiber was associated with an insignificant increase in HDL-C (4.6%) [24]. In the study performed in China, a total of 110 elderly people with hyperlipidemia were randomly assigned to the experimental group who consumed an ordinary diet plus foods containing refined konjac meal, and the control group who consumed only the ordinary diet for 45 days [25]. At the end of the trial, HDL-C was significantly reduced, but only by a small amount (0.0353 mmol/L, 95% CI: 0.0003 - 0.0514).

The present study showed a significant association between dietary fiber intake and reduction of LDL-C; however, it did not demonstrate a significant influence on HDL-C.

**Conclusions**

In spite of significant associations of low GI and dietary fiber intake with reduction of LDL-C, we could not observe any significant influences of low GI and dietary fiber intake on HDL metabolism.

**Conflict of Interest**

The authors declare that they have no competing interests.

**References**


4. Schwingshackl L, Hobl LP, Hoffmann G. Effects of low glycemic index/low glycemic load vs. high glycemic index/high glycemic load diets on overweight/obesity and associated risk factors in children and adolescents: a...


