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Apolipoprotein B is a better marker than non-HDL-cholesterol for the metabolic syndrome in Koreans

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Abstract

Apolipoprotein B (apoB) concentration reflects the number of atherogenic particles and is closely associated with atherosclerosis. Non-HDL-cholesterol (non-HDL-C) has been considered a therapeutic target for patients with hypertriglyceridemia. We compared the predictive values of apoB and non-HDL-C for the metabolic syndrome (MetS) in 3335 Korean adults (mean age, 45.2 years) who participated consecutively in a health examination in a university hospital. Anthropometry, blood pressure, fasting glucose, lipid profiles and apoB were measured. MetS, as defined by a modification of the NCEP-ATP III criteria, was present in 22.1% of men and 16.1% of women. Among the components of the MetS, triglycerides showed the strongest correlation with apoB ($r = 0.393$, $P < 0.001$ in men, and $r = 0.326$, $P < 0.001$ in women) and non-HDL-C ($r = 0.376$, $P < 0.001$ in men, and $r = 0.349$, $P < 0.001$ in women). When apoB and non-HDL-C were mutually adjusted, the ORs for the MetS of non-HDL-C were not significant. As a function of the quartile of apoB levels, the ORs for the MetS were 2.04 (1.26–3.30), 3.54 (2.11–5.93), and 5.38 (3.16–9.17) in men (P for trend <0.001) and 3.75 (1.42–9.87), 5.55 (2.09–14.69), and 13.41 (5.02–35.79) in women (P for trend <0.001), respectively. These findings indicate that apoB is a better marker than non-HDL-C for identifying the MetS among Koreans.

Keywords: Apolipoprotein B; Non-HDL-cholesterol; Metabolic syndrome; Prediction; Korean

1. Introduction

The metabolic syndrome (MetS), a clustering of cardiovascular risk factors and metabolic abnormalities [1], is associated with an increased risk for cardiovascular disease [2,3]. The most widely recognized of these metabolic risk factors are atherogenic dyslipidemia, elevated blood pressure, and elevated fasting blood glucose.

Atherogenic dyslipidemia consists of an aggregation of lipoprotein abnormalities, including elevated serum triglycerides and apolipoprotein B (apoB), increased small LDL particles, and a reduced level of HDL-cholesterol (HDL-C) [4], all of which are commonly observed in patients with the MetS. Current standards indicate that non-HDL-C concentration may be used for clinical decision making in hypertriglyceridemic patients [5]. However, apoB identifies high-risk dyslipidemic patients who are not detected by standard lipid profiles.

Although non-HDL-C and apoB may be equivalent risk markers in hypertriglyceridemia, apoB can also identify high-risk dyslipidemic phenotypes in type 2 diabetic patients with normotriglyceridemia [6]. Despite the high correlation between non-HDL-C and apoB concentration [7,8], non-HDL-C concentration is a marker for cholesterol content in atherogenic lipoproteins, whereas apoB concentration is a

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marker for the total number of particles containing non-HDL-C [9]. Recently, apoB is considered as a key component in an expanded definition of the MetS [10].

There have been few comparisons, however, of non-HDL-C and apoB as markers for the MetS. We therefore compared the predictive value of apoB and non-HDL-C concentrations for the MetS among Koreans.

2. Research design and methods

2.1. Study subjects

A total of 3642 study subjects were included, all of whom had undergone regular health examinations from 2005 to 2006 at Eulji Medical Center in Seoul, Korea. All individuals underwent a medical evaluation by physicians, including a medical history and physical examination. Subjects excluded from this study included pregnant and lactating women, and those with secondary causes of obesity, malignancy, thyroid disorders, severe hepatic or renal diseases and increased fasting triglycerides (≥400 mg/dL). After exclusions, 3335 subjects (1671 men and 1664 women), aged 20–78 years, remained eligible. The study was approved by the Institutional Review Board of Eulji Medical Center.

2.2. Clinical evaluations

Anthropometric measurements were made with the subjects in light clothing and without shoes. Height and weight were measured using an automatic height–weight scale to the nearest 0.1 cm and 0.1 kg, respectively. Waist circumference (WC) was measured at the midpoint between the lower border of the rib cage and the iliac crest. Blood pressure was measured with a standardized sphygmomanometer after a 10 min rest in the sitting position.

2.3. Biochemical measurements

Following a 12 h fast, blood was obtained in the morning from an antecubital vein into Vacutainer tubes and subsequently analyzed at a central, certified laboratory. Fasting glucose was measured using a glucose oxidase method, and total cholesterol (TC), triglycerides and HDL-C levels were measured using enzymatic colorimetric procedures with an autoanalyzer (Hitachi-747; Hitachi, Tokyo, Japan). LDL-cholesterol (LDL-C) was estimated indirectly according to the Friedewald formula for triglycerides <400 mg/dL [11]. Non-HDL-C was calculated by subtracting HDL-C from TC. Serum apoB concentrations were determined by an immunoturbidometric method (Cobas Integra 800 automatic analyzer; Roche Diagnostics, Basel, Switzerland; CV, <3.2%). Serum insulin concentration was measured by chemiluminescent immunoassay (Immulite 2000, Diagnostic Products Corp., Los Angeles, CA; CV, <7%). Insulin resistance was measured using the homeostasis model assessment (HOMA) of insulin resistance index (fasting glucose [mmol/L] × fasting insulin [μU/mL]/22.5) [12].

2.4. Definition of the metabolic syndrome

Participants were classified as having the MetS according to the 2005 revision of NCEP ATP III criteria [4] and Korean-specific cutoffs for abdominal obesity [13]. The MetS was defined as three or more of the following: (1) WC ≥90 cm in men and ≥85 cm in women, (2) systolic and/or diastolic

Table 1
Metabolic components and lipid measures in participants with and without the metabolic syndrome

Variables	Men			Women		
	MetS(−) (n = 1302)	MetS(+) (n = 369)	P	MetS(−) (n = 1396)	MetS(+) (n = 268)	P
Age (years)	44.7 ± 11.3	47.7 ± 10.9	<0.001	42.8 ± 12.6	56.6 ± 9.9	<0.001
Height (cm)	170.2 ± 6.4	170.3 ± 6.1	NS	158.1 ± 5.8	154.9 ± 5.1	<0.001
Weight (kg)	68.8 ± 9.3	77.8 ± 9.3	<0.001	56.0 ± 7.3	64.1 ± 9.2	<0.001
BMI (kg/m^2)	23.7 ± 2.7	26.8 ± 2.4	<0.001	22.4 ± 2.8	26.7 ± 3.4	<0.001
Waist circumference (cm)	83.1 ± 7.0	91.9 ± 6.0	<0.001	75.6 ± 8.3	88.5 ± 7.6	<0.001
Systolic blood pressure (mmHg)	122.4 ± 12.5	134.2 ± 13.2	<0.001	117.7 ± 13.3	136.6 ± 15.5	<0.001
Diastolic blood pressure (mmHg)	74.0 ± 9.6	81.7 ± 11.1	<0.001	71.0 ± 9.6	81.2 ± 11.1	<0.001
Fasting glucose (mg/dL)	95.9 ± 23.1	113.9 ± 37.7	<0.001	90.8 ± 13.5	108.8 ± 27.8	<0.001
Triglycerides (mg/dL)	122.6 ± 64.7	202.8 ± 75.4	<0.001	83.6 ± 43.5	174.5 ± 74.9	<0.001
HDL-C (mg/dL)	50.2 ± 10.5	43.2 ± 9.8	<0.001	58.2 ± 11.8	46.1 ± 9.1	<0.001
TC (mg/dL)	186.7 ± 31.3	195.0 ± 34.8	<0.001	185.1 ± 33.4	203.3 ± 34.7	<0.001
LDL-C (mg/dL)	112.1 ± 28.6	111.2 ± 33.1	NS	110.2 ± 30.0	122.3 ± 33.6	<0.001
Non-HDL-C (mg/dL)	136.6 ± 30.6	151.8 ± 33.0	<0.001	126.9 ± 32.8	157.2 ± 33.4	<0.001
ApoB (mg/dL)	86.5 ± 23.5	99.7 ± 22.6	<0.001	77.4 ± 24.9	100.1 ± 23.5	<0.001
Insulin (μU/mL)	4.4 ± 2.8	6.7 ± 3.2	<0.001	4.3 ± 2.4	6.8 ± 3.7	<0.001
HOMA	1.0 ± 0.7	1.9 ± 1.0	<0.001	1.0 ± 0.6	1.8 ± 1.2	<0.001

Abbreviations are as defined in the text. Values are mean ± SE. P-values were calculated using Student's t-test. The metabolic syndrome was defined as three or more of the following: (1) WC ≥90 cm in men and ≥85 cm in women, (2) systolic and/or diastolic blood pressures ≥130/85 mmHg or drug treatment for hypertension, (3) fasting glucose ≥100 mg/dL or drug treatment for elevated glucose, (4) fasting triglycerides ≥150 mg/dL or drug treatment for elevated triglycerides, (5) fasting HDL-C <40 mg/dL in men and 50 mg/dL in women or drug treatment for reduced HDL-C.