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ORIGINAL ARTICLE

Associations Between Estimated Desaturase Activity and Insulin Resistance in Korean Boys

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Abstract
Objectives: Obesity in childhood increases the risk of obesity in adulthood, and is predictive of the development of metabolic disorders. The fatty acid compositions of various tissues, including blood, are associated with obesity and obesity-associated disorders. Thus, tracking plasma phospholipid (PL) features and metabolic parameters in young individuals may strengthen the utility of fatty acid composition as an early biomarker of future metabolic disorders.
Methods: Anthropometric and blood biochemical data were obtained from 131 Korean males aged 10.5 ± 0.4 years, and followed up at 2 years. We analyzed the plasma PL fatty acids according to obesity. Obese children were defined as those with a body mass index (BMI) greater than the 85th percentile for age and gender, based on Korean child growth standards.
Results: Activities of lipid desaturases, stearyl-CoAD (SCD-16,16:1n-7/16:0), delta-6D (D6D, 20:3n-6/18:2n-6), and delta-5D (D5D, 20:4n-6/20:3n-6), were estimated. Obese individuals had significantly higher proportions of palmitoleic acid (16:1n-7) and dihomo-gamma linolenic acid (DGLA, 20:3n-6) at both baseline and follow-up than did lean individuals. The activities of SCD-16 and D6D were higher in obese than lean boys. The baseline SCD-16 activity level was positively associated with the baseline waist circumference (WC) and the metabolic risk score. The baseline D6D level was positively associated with WC and also with the

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homeostasis model of assessment of insulin resistance (HOMA-IR), a surrogate marker of insulin resistance (IR), and metabolic risk score at both baseline and follow-up.
Conclusion: In young Korean males, higher D6D activity predicts the future development of IR and associated metabolic disorders including dyslipidemia.

1. Introduction

Obesity has become increasingly prevalent among children and adolescents in many countries. Childhood obesity increases the risk of developing health problems including insulin resistance (IR) and metabolic syndrome [1,2], and also adult obesity and cardiovascular disease [3,4]. Therefore, early detection of childhood obesity and metabolic disorders is required to efficiently prevent development of problems in adulthood. Studies on child populations may clarify the mechanisms underlying the development of obesity and metabolic disorders, because problems in children are not confounded by the consequences of advanced metabolic disorders.

The levels of specific serum fatty acids and fatty acid desaturases have been suggested to serve as useful biomarkers predicting the development of IR and metabolic disorders [5−11]. Higher levels of saturated fatty acids, palmitoleic acid, linoleic acid, and dihomo-gamma linolenic acid (DGLA), have been reported to be associated with obesity and metabolic syndrome. In addition, both animal and human studies have suggested that fatty acid desaturases play roles in various metabolic disturbances, including dyslipidemia and IR [12]. The data have been derived principally from cross-sectional studies, which cannot predict the future development of obesity and metabolic disorders. Longitudinal studies can yield integrated information on the development of metabolic disorders over time, and can identify the optimal points of intervention [13]. Therefore, in the present study, we explored the longitudinal relations of plasma phospholipid (PL) fatty acid composition and desaturase activities to IR and metabolic risk factors in Korean boys.

2. Materials and methods

2.1. Study participants and anthropometric parameters

This study is part of the Korean Children and Adolescent Cohort Study, which follows a student cohort from the time of entry into elementary school (at 7 years of age) to graduation (at age 19 years) in Seoul and Kyunggi provinces, Korea. The overall objective of the cohort study is to identify early risk factors for obesity and associated metabolic disease. The study was approved by the Institutional Review Board of the Korea Center for Disease Control and Prevention and the Ethics Committee of Seoul-Paik Hospital, Inje University, Seoul, Korea. Informed parental consent was obtained for each individual prior to enrolment. Body weight and body fat percentage were measured using a body composition analyzer (BC418; Tanita, Tokyo, Japan) and height was measured using an automatic stadiometer (DS-102; Jenix, Seoul, Korea). Obese children were defined as those with a body mass index (BMI) greater than the 85th percentile for age and gender, based on Korean child growth standards [14]. A total of 131 boys aged 9−11 years in 2008−2009 were included. After 2 years, health data were obtained once more.

2.2. Biochemical analysis

Each blood sample was collected from an antecubital vein into a vacutainer tube between 9:00 AM and 11:00 AM after a 12-hour overnight fast. Within 30 minutes, plasma and serum were separated and stored at −80°C prior to further analysis. The levels of triglyceride (TG), total cholesterol, high-density lipoprotein-cholesterol (HDL-C), alanine aminotransferase (ALT), aspartate aminotransferase (AST), and glucose were measured using an autoanalyzer (model 7600II; Hitachi, Tokyo, Japan). The fasting serum insulin level was measured using a Roche E170 instrument (Roche Diagnostics, Mannheim, Germany). The IR index was calculated using the homeostasis model assessment of insulin resistance (HOMA-IR) [15]. A metabolic risk score was constructed by summing the *z*-score of five metabolic risk factors, which are BMI, systolic blood pressure (SBP), TG, HDL-C, and HOMA-IR [16].

2.3. Fatty acid analysis

Plasma lipids were extracted using a modification of the method of Folch et al [17]. The PL fraction was isolated by thin-layer chromatography and the fatty acids were converted into methyl esters using the method of Lepage and Roy [18]. The composition of the methylated fatty acid mix was determined by gas chromatography (HP 7890A; Hewlett-Packard, Palo Alto, CA, USA). Individual fatty acids were identified by comparing retention times to those of standards and quantified based on the peak area relative to the total methylated fatty acid peak area (set at 100%). Desaturase levels were estimated by calculating the product:precursor ratios of individual fatty acids (using the proportions calculated above) as follows: delta-6D (D6D) = [20:3n-6/18:2n-6]; delta-6D (D5D) = [20:4n-6/20:3n-6]; stearyl-CoAD-16 (SCD-

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