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Plasma lipid fatty acid composition, desaturase activities and insulin sensitivity in Amerindian women

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Abstract *Background and aims:* Two Amerindian populations – Shuar women living in the Amazonian rain forest under traditional conditions and urbanized women in a suburb of Lima were studied. The fatty acid composition in plasma lipids and the relationships between fatty acid composition and metabolic variables were studied, as well as in a reference group of Swedish women.

Methods and results: Fasting plasma was used for analyses of glucose, insulin, leptin and fatty acid composition. Women in Lima had more body fat, higher fasting insulin and leptin and lower insulin sensitivity than the Shuar women, who had insulin sensitivity similar to Swedish women. Shuar women had very high proportions (mean; SD) of palmitoleic (13.2; 3.9%) and oleic (33.9; 3.7%) acids in the plasma cholesteryl esters with very low levels of linoleic acid (29.1; 6.1 3%), as expected on a low fat, high carbohydrate diet. The estimated activity of delta 9 (SCD-1) desaturase was about twice as high in the Shuar compared with Lima women, suggesting neo lipogenesis, while the delta 5 desaturase activity did not differ. The Lima women, as well as the Swedish, showed strong positive correlations between SCD-1 activity on the one hand and fasting insulin and HOMA index on the other. These associations were absent in the Shuar women.

Conclusions: The high SCD-1 activity in the Shuar women may reflect increased lipogenesis in adipose tissue. It also illustrates how a low fat diet rich in non-refined carbohydrates can be linked to a good metabolic situation.

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Introduction

Transition from original hunter/gatherer communities through agriculture to an urbanized community usually leads to a dramatic change of lifestyle with lower energetic stress, greater adiposity and an increased risk to develop diabetes and cardiovascular diseases [1,2]. During this transition there are pronounced dietary changes. From a diet usually low in fat and high in carbohydrates and dietary fibre there is a switch to a "Westernized diet", with a higher content of fat and less fibre rich, carbohydrate containing foods, but with more refined starch rich foods and added sugar. The high energy density of the food, in combination with a sedentary lifestyle, favours development of obesity and diabetes [3].

A low proportion of unsaturated fat and a high proportion of saturated fat and refined carbohydrates in the diet have been related to an increased risk for atherosclerotic cardiovascular disease and diabetes. The assessment of fat intake from different food sources is, however, associated with substantial measurement errors. An analysis of the composition of serum fatty acids is probably a more objective and accurate way to mirror the dietary fat quality [4,5].

We have studied two female Amerindian populations with different lifestyle. The first group of Shuar women is living in the Ecuadorian part of the Amazonian rain forest. They have retained traditional living conditions with predominantly hunter/gatherer lifestyle. The second group consists of urbanized women living as residents of a northern suburb of Lima, the capital of Peru. The women in the first group are characterized by a low proportion of body fat with low levels of plasma insulin and leptin and good insulin sensitivity [6]. The women in the second group are fatter, more insulin resistant with higher plasma leptin levels. The aim of our study was to analyse the fatty acid composition in plasma lipids in the two groups of women, compared to a reference group of Swedish women, and to study the relationships between the fatty acid patterns and variables related to insulin sensitivity.

Methods

The Shuar women were living in small Amerindian communities located in the Amazonian rain forest at an altitude of 700 m in the Pastanza region in Ecuador. The majority had maintained a traditional hunter/gatherer lifestyle. Piped water or electricity was not available in their home communities. The Lima women were Peruvian Amerindian living in the Northern urban area of Lima. A migration antecedent from indigenous Andean communities was identified in all participants.

All women aged 20–61 years living in the Shuar settlements were invited to take part in the study. The participation rate ($n = 59$) exceeded 95%. The mean age was 35.7 (range 20–61) years. The women living in Lima ($n = 141$) had a mean age of 40 years (range 20–59 years). The study population was earlier described [7]. A group of Swedish women ($n = 295$, mean age 40.6 years), employees of a telephone company in Uppsala, Sweden, participating in a health survey regarding coronary heart disease [8] is used

as a reference group. Ninety percent of the female employees took part in the survey. The studies were undertaken in accord with the Helsinki declaration of 1975, as revised in 1983.

The examination of all women was done in the morning after an overnight fast. Body height and weight were measured. Body adiposity was measured by a bioimpedance method (The Biodynamic Model 310, version 8.0, Biodynamic Research, Seattle, WA). A venous blood sample (6 ml) was obtained in Vacuette test tubes immediately after aprotinin (250 KIU/ml blood, Bayer AG, Leverkusen, Germany) was added. The blood was centrifuged, plasma was stored in an ice cooler with blue pack ice at 4 °C for 24–30 h and kept frozen for 3 days at –20 °C, and then brought to Sweden for analyses. Plasma glucose was measured by the glucose oxidase procedure. Insulin and leptin were analyzed with double-antibody radioimmunoassay techniques (Linco Research, t Charles, MO). For the indirect determination of insulin sensitivity, the homeostasis model assessment of insulin resistance (HOMA-IR) was calculated as follows: fasting insulin (in pmol/L) \times fasting glucose (in mmol/L)/22.5 [9]. Plasma lipid fatty acid composition was measured by gas-liquid chromatography using a 25-m NB-351 silica capillary column as earlier described [10]. The CV between successive gas chromatography runs was 0.2–5%. The relative amount of fatty acids was expressed as a percentage of the total amount of fatty acids reported.

The desaturase activities were estimated as the product/precursor ratios of individual fatty acids in the lipid esters according to the following: delta 9 desaturase (stearoyl-CoA desaturase, SCD-1) = 16:1 n-7/16:0, delta 6 desaturase = 18:3 n-6/18:2 n-6, delta 5 desaturase 20:4 n-6/20:3-n-6.

Statistics

All results are presented as mean values \pm SD. Differences between the groups were analyzed using Mann–Whitney *U* test. The correlation coefficients between 2 variables were determined by Spearman rank analysis. A *p*-value of < 0.05 was considered significant.

All statistical analyses were conducted by using the statistical package STATVIEW (version 5.0.1, for Macintosh; SAS Institute Inc, Cary, NC).

Results

The Shuar women were on average somewhat younger than the women from Lima, who were slightly over-weight with a significantly higher proportion of body fat (Table 1) and high fasting insulin levels and HOMA index suggesting pronounced insulin resistance. The women in the Swedish reference group were of the same age as the Lima women, but the mean BMI, fasting insulin and HOMA index were similar to those of the Shuar women. The plasma glucose did not differ between the groups, but the leptin concentrations were nearly three times higher in the Lima women than among the Shuar women, as earlier reported [6,11].

There were major differences between the plasma cholesteryl ester fatty acid pattern in Amerindian women

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