Plasma Lipid Peroxide Levels in an Urbanized Micronesian Population—Nauru

Kunio YAGI,1 Shigeru MATSUOKA,1 Anthony W. LINNANE,2 and Paul ZIMMET3

1Institute of Biochemistry, Faculty of Medicine, University of Nagoya, Nagoya 466, Japan
2Department of Biochemistry, Monash University, Melbourne, Australia
3Department of Metabolic Medicine and Epidemiology, Royal Southern Memorial Hospital, Melbourne, Australia

(Received April 23, 1981)

Summary Plasma lipid peroxide levels of 419 inhabitants of Nauru, where a high prevalence of obesity is occurring, were measured. The plasma lipid peroxide level was 4.03 ± 1.94 nmol/ml in subjects 20–24 years and rose to a peak of 5.78 ± 3.21 in subjects 35–44 years. The values obtained with Nauruans are significantly higher than those of healthy Japanese people and the peak found in the former was shifted to a younger age than in the Japanese.

Key Words plasma lipid peroxide, Micronesian population

An accumulation of lipid peroxides in animal tissue has been considered a cause of degenerative disorders such as atherosclerosis(1, 2), retinal degeneration(3, 4) and ethanol-induced liver injury(5). Recently, one of us devised a simple reliable method for the microdetermination of lipid peroxides in plasma or serum(6). This has enabled us to investigate the relation between lipid peroxide level in plasma and degenerative disorders. Using this method, it has been demonstrated that a correlation exists between plasma lipid peroxide level and some degenerative diseases such as angiopathy in diabetes(7).

On the other hand, it has been reported that there are unique ethnic groups in the developing countries of the Pacific which, coincident with modernization of their life-style, show a significant increase in chronic degenerative diseases such as diabetes, hypertension, obesity, heart disease and gout-conditions previously unknown or rare in these populations(8, 9). Especially in Nauru, one of those countries in Micronesia, the prevalence of diabetes was 44% in people aged 20 years and over as reported by Zimmet and his co-workers(10). We thought it worthwhile to determine the lipid peroxide levels in plasma of the inhabitants in Nauru.

1 八木國夫, 松岡 繁, 2 アントニー W. リネ, 3 ポール ジメット

425
SUBJECTS AND METHODS

Nauru is one of the most isolated islands in the Central Pacific and is 2,500 miles from Sydney and 3,000 miles from Tokyo. As a result of rich phosphate deposits, the Nauruans have one of the highest per capita incomes in the world, US $30,000/annum. With increasing wealth and the resulting modernization of lifestyle, the traditional island diet has been replaced by one of a variety of imported western foods. A recent dietary survey on the Nauruans showed a calorie intake ranging from 5,000–7,000 in the adult population (8). There is a high prevalence of obesity in the Nauru population and decreased physical activity in relation to the very high calorie intake is probably the major reason for this.

The subjects were 419 inhabitants (185 males and 234 females), equivalent to 1/4 of the total adult Nauruan population. Fasting blood was taken by a heparinized syringe. The lipid peroxide levels in plasma were measured according to Yagi (6), and expressed as nmol in terms of malondialdehyde per ml plasma.

RESULTS AND DISCUSSION

The age- and sex-specific data are shown in Table 1. The plasma lipid peroxide level was 4.03 nmol/ml in age group I (20–24 years) and rose to a peak of 5.78 nmol/ml in age group III (35–44 years). There were no significant differences between the males and the females in each of the age groups.

Figure 1 shows the frequency distributions of lipid peroxide levels in the combined sexes, males and females separately. The distributions conform to a unimodal Gaussian pattern with some skewing to the right.

Since no significant change was found between the lipid peroxide level of serum and that of plasma, we compared the values of plasma obtained with Nauruan

| Age (years) | Males | Females | Total |
|-------------|-------|---------|-------|
| I (20–24)   | 4.19 ± 1.76 (27) | 3.91 ± 2.07 (39) | 4.03 ± 1.94 (66) |
| II (25–34)  | 4.80 ± 2.16 (53) | 5.03 ± 1.73 (78) | 4.94 ± 1.91 (131) |
| III (35–44) | 5.84 ± 3.28 (38) | 5.72 ± 3.18 (43) | 5.78 ± 3.21 (81) |
| IV (45–54)  | 4.59 ± 2.64 (42) | 5.56 ± 2.94 (42) | 5.07 ± 2.82 (84) |
| V (55–64)   | 3.91 ± 1.46 (16) | 4.20 ± 1.80 (22) | 4.08 ± 1.65 (38) |
| VI (65– )   | 3.89 ± 2.63 (9) | 4.67 ± 1.61 (10) | 4.30 ± 2.13 (19) |
| Total       | 4.76 ± 2.52 (185) | 4.97 ± 2.41 (234) | 4.88 ± 2.46 (419) |

* Lipid peroxide level is expressed in terms of malondialdehyde (nmol/ml plasma). Mean ± SD (n) is given. Significance test for the total: I–II*, I–III**, I–IV**, II–III*, II–V*, III–V*, IV–V*, where *p<0.05; †p<0.01; ††p<0.001.

J. Nutr. Sci. Vitaminol.
PLASMA LIPID PEROXIDE LEVEL

Fig. 1. Frequency distribution of lipid peroxide levels of Nauruan subjects. Lipid peroxide level is expressed in terms of malondialdehyde (nmol/ml plasma). A, combined sexes \(n=419\); B, males \(n=185\); C, females \(n=234\).

people with those of sera obtained with healthy Japanese people. The value obtained with healthy Japanese people aged 21–31 years was 3.14 nmol/ml for males and 2.98 nmol/ml for females, and the values increased with age up to 61–70 and then decreased \(11\). It is noted that the values obtained with Nauruans are significantly higher than those of healthy Japanese and that the peak found in the former was shifted to a younger age group than in the Japanese.

We believe that this is related to the state of health in Nauruans, in that a large percentage are diabetics or potential diabetics and the average age of death amongst Nauruan diabetics is \(\approx 45\) years. Taking into consideration the previous report that diabetics with angiopathies had a high level of lipid peroxides in plasma \(7\), the present results could suggest that the high lipid peroxide levels are due to the increasing number of diabetics with angiopathies with age in this population. In fact, a high prevalence of diabetic retinopathy in the population in Nauru has been reported \(9\).

We have previously observed that the age-specific diabetes prevalence and incidence rates do decline in the older age groups in the Nauru population \(12\) just as did the mean plasma lipid peroxide levels. These findings are consistent with the suggestion that this decrease can be explained by the increased mortality in Nauruans with diabetes.

This work was supported by a grant from the Japan Society for the Promotion of Science.

REFERENCES

1) Glavind, J., Hartmann, S., Clemmensen, J., Jensen, K. E., and Dam, H. (1952): Studies on the role of lipoperoxides in human pathology. II. The presence of peroxidized lipids Vol. 27, No. 5, 1981
in the atherosclerotic aorta. *Acta Pathol.*, **30**, 1–6.

2) Dormandy, J. A., Hoare, E., Colley, J., Arrowsmith, D. E., and Dormandy, T. L. (1973): Clinical haemodynamic rheological, and biochemical findings in 126 patients with intermittent claudication. *Br. Med. J.*, **8**, 576–583.

3) Hiramitsu, T., Hasegawa, Y., Hirata, K., Nishigaki, I., and Yagi, K. (1976): Formation of lipoperoxide in the retina of rabbit exposed to high concentration of oxygen. *Experientia*, **32**, 622–623.

4) Hiramitsu, T., Majima, Y., Hasegawa, Y., Hirata, K., and Yagi, K. (1976): Lipoperoxide formation in the retina in ocular siderosis. *Experientia*, **32**, 1324–1325.

5) Di Luzio, N. R., and Hartman, A. D. (1967): Role of lipid peroxidation in the pathogenesis of the ethanol-induced fatty liver. *Fed. Proc.*, **26**, 1436–1442.

6) Yagi, K. (1976): A simple fluorometric assay for lipoperoxide in blood plasma. *Biochem. Med.*, **15**, 212–216.

7) Sato, Y., Hotta, N., Sakamoto, N., Matsuoka, S., Ohishi, N., and Yagi, K. (1979): Lipid peroxide level in plasma of diabetic patients. *Biochem. Med.*, **21**, 104–107.

8) Ringrose, H., and Zimmet, P. (1979): Nutrient intakes in an urbanized Micronesian population with a high diabetes prevalence. *Am. J. Clin. Nutr.*, **32**, 1334–1341.

9) Zimmet, P. (1979): Epidemiology of diabetes and its macrovascular manifestations in Pacific populations: The medical effects of social progress. *Diabetes Care*, **2**, 144–153.

10) Zimmet, P., Arblaster, M., and Thoma, K. (1978): The effect of westernization on native populations. Studies on a Micronesian community with a high diabetes prevalence. *Aust. N. Z. J. Med.*, **8**, 141–146.

11) Suematsu, T., Kamada, T., Abe, H., Kikuchi, S., and Yagi, K. (1977): Serum lipoperoxide level in patients suffering from liver diseases. *Clin. Chim. Acta*, **79**, 267–270.

12) Zimmet, P., and Whitehouse, S. (1979): The effect of age on glucose tolerance—Studies on a Micronesian population with a high prevalence of diabetes. *Diabetes*, **28**, 617–623.

*J. Nutr. Sci. Vitaminol.*