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Thiamine Deficiency is Prevalent in a Selected Group of Urban Indonesian Elderly People[1,2,3]

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ABSTRACT   This cross-sectional study involved 204 elderly individuals (93 males and 111 females). Subjects were randomly recruited using a list on which all 60–75 y-old-people living in seven sub-villages in Jakarta were included. The usual food intake was estimated using semiquantitative food frequency questionnaires. Hemoglobin, plasma retinol, vitamin B-12, red blood cell folate and the percentage stimulation of erythrocyte transketolase (ETK), as an indicator of thiamine status, were analyzed. Median energy intake was below the assessed requirement. More than 75% of the subjects had iron and thiamine intakes of ~2/3 of the recommended daily intake, and 20.2% of the study population had folate intake of ~2/3 of the recommended daily intake. Intakes of vitamins A and B-12 were adequate. Biochemical assessments demonstrated that 36.6% of the subjects had low thiamine levels (ETK stimulation $> 25\%$). The elderly men tended to have lower thiamine levels than the elderly women. The overall prevalence of anemia was 28.9%, and the elderly women were affected more than the elderly men. Low biochemical status of vitamins A, B-12 and RBC folate was found in 5.4%, 8.8 % and 2.9% of the subjects, respectively. Dietary intakes of thiamine and folate were associated with ETK stimulation and plasma vitamin B-12 concentration ($r = 0.176$, $P = 0.012$ and $r = 0.77$, $P = 0.001$), respectively. Results of this study suggest that anemia, thiamine and possibly vitamin B-12 deficiency are prevalent in the elderly living in Indonesia. Clearly, micronutrient supplementation may be beneficial for the Indonesian elderly population living in underprivileged areas.   J. Nutr. 129: 366–371, 1999.

KEY WORDS: • Body mass index • thiamine • Indonesian elderly • micronutrients • anemia

In most industrialized countries the number of elderly people is increasing due to an improvement in health care and a reduction in birth rates during the past decades (WHO 1989). Population aging is not only occurring in industrialized countries, but also in developing countries. It is estimated that in the Southeast Asian region the proportion of individuals older than 60 y will increase from 5% in 1950 to 11.5% in 2050, equivalent to a four-fold increase in absolute numbers (Gopalan 1992).

The aging process is associated with physiological, psychological and socioeconomic changes leading to nutritional excess, such as obesity, and deficit, such as micronutrient deficiency, and their related health outcomes, such as coronary atherosclerosis, diabetes mellitus, certain cancers and anemia. These changes and outcomes are evidenced from various studies of elderly people living in industrialized countries (de Groot et al. 1991, Hartz et al. 1992, Kromhout et al. 1990, Wahlqvist et al. 1995a and b).

So far, a limited number of studies have been undertaken to observe the nutritional status of the elderly living in developing countries. The Western Pacific study (Andrews et al. 1986) described sociocultural factors, but not nutritional factors, of free-living, elderly people living in Fiji, the Republic of Korea, Malaysia and the Philippines. Recently, Wahlqvist et al. (1995a) reported the food habits, lifestyles and health status among the aged in developed and developing countries. Elderly people living in developing countries have, up to a certain degree, an inadequate intake of micronutrients, such as vitamin A, thiamine, riboflavin and vitamin C (Wahlqvist et al. 1995b). However, for certain micronutrients, intakes are not reflected in plasma or serum levels. In free-living, middle- to upper-class, US elderly, 24% of the men and 39% of the women had vitamin B-12 intakes below three-fourth of the recommended dietary allowance (RDA)[5]; most of these people were able to maintain normal levels of serum vitamin B-12 despite the low intakes (Ahmed 1992). Little information is available about nutritional status of the elderly in Indonesia, but it is expected that inadequate food intake is common (Horwath 1989). This was confirmed by a recent study showing a high prevalence of low body mass index (BMI) (Rabe et al. 1996) among elderly from Jakarta. A low food intake

increases the risk of micronutrient deficiencies, especially when the micronutrient density and/or bioavailability in food is low, which is often the case with diets in developing countries. A factor complicating nutritional status of the elderly in developing countries is that many may have had inadequate food intake during much of their childhood and adult life.

The aim of this study was to investigate the nutrient intake, selected anthropometric and biochemical indicators, and their associations, of noninstitutionalized elderly living in urban Jakarta, Indonesia.

SUBJECTS AND METHODS

Study design. This cross-sectional study was carried out between March and April 1996, in two sub-villages of Johor-Baru sub-district in Central-Jakarta. The Johor-Baru sub-district had a total population of ~108,000 persons and a population density of ~40,000 people/km². The population of the two sub-villages from which the subjects were selected was ~51,700, of which an estimated 4,400 people were older than 60 y. Environmental sanitation in the study area was poor, with most households having an open drainage system. The majority of households belonged to the low socioeconomic class.

Subjects. Subjects were randomly selected from a list obtained from the municipality including all inhabitants who were aged from 60 to 75 y. Excluded were those elderly with a serious illness, who were immobile, and who were institutionalized. Furthermore, a cognitive test was conducted among the potential subjects to ensure that they would be able to answer questionnaires. This test consisted of five simple cognitive questions and five questions on food identification, making a total of 10 questions. Subjects were considered eligible for the study if they could provide correct answers to five questions or more. A total of 204 subjects were enrolled in the study. Home visits were undertaken by the interviewers with the assistance of local aides to contact these 204 subjects. All subjects agreed to participate in and successfully completed the study. Written consent was obtained from each subject prior to the commencement of the study.

Questionnaire. Selected information on socioeconomic status, lifestyle and health status was collected using a precoded questionnaire. Habitual food intake was assessed using a semiquantitative food frequency questionnaire. Subjects were asked about 71 food items. Food models and pictures were used for identification of the foods. Each food had a corresponding serving portion, and each serving portion had a corresponding weight. The amount of foods consumed was quantified by multiplying the daily frequency of consumption by the number of serving portions consumed and thier corresponding weights. The Indonesian (Departemen Kesehatan R. I. 1991) food composition tables were used to convert foods into nutrients. A European food composition table (Holland et al. 1993) was used to obtain vitamin B-12 and folic acid intakes because information on these nutrients is not available in the Indonesian food composition tables. Nutrient analysis was done using the computer program DEMETER 1.5 (Northern Technical Data, Winnipeg). A qualitative question (with yes or no responses) was used to assess supplement intake.

Anthropometric measurement. Anthropometric measurements consisted of weight, height, arm span and skinfolds of biceps, triceps, supra-iliac, and sub-scapula. Between 8.00 and 10.00 h, weight was measured to the nearest 0.1 kg using a platform model electronic weighing scale (SECA 770 Alpha, Hamburg, Germany). During the measurement, subjects were wearing a minimum of clothing for which no correction was made. Stature was measured to the nearest 0.1 cm using a microtoise (Stanley Mabo, London, UK), with the subject standing as erect as possible with the back against a wall. Arm span was measured to the nearest 0.1 cm using a 2-m measuring bar. Subjects were asked to stand with their backs against the wall, both arms extended laterally at shoulder level to the maximum with the tip of the right hand middle finger at the zero mark of the measuring bar. The reading was made at the point where the tip of the left hand middle finger touched the opposite side of the bar. Four skinfolds (biceps, triceps, subscapular and suprailiac) (Durnin and Womersley 1974) were measured in duplicate at the left-hand side of the body

using a Holtain caliper. All skinfold measurements were made by the same person, and the mean of the two measurements was taken from each person.

Biochemical assessment. Between 800 and 1000 h, after an overnight fast, venous blood (6 mL) was collected from each subject into tubes containing EDTA. After collection, the blood specimens were immediately placed in a dark cool box until they arrived at the laboratory. Hemoglobin and red blood cell folate concentrations were determined within 2–3 h after blood collection. Hemoglobin analysis was carried out using the cyanomethemoglobin method (INACG 1985). Red blood cell folate assessment was based on an ion capture assay method using a commercial kit purchased from Abbott Laboratory (Imx-Folate, Abbott Park, IL). Thiamine status was determined by measuring the erythrocyte transketolase (ETK) activity (Brin 1967, Schouten et al. 1964). The basal ETK activity and its activity after adding thiamine pyrophosphate (TPP) were used to calculate the TPP effect, which is considered to be an indicator for thiamine status. The coefficient of variation, CV, for basal ETK activity is ~5% for both within- and between-day analyses. The corresponding values for ETK activity are ~2 and 4%, respectively (Fidanza, 1991).

Plasma specimens were obtained by centrifuging the blood samples at $3000 \times g$ for 10 min at room temperature (25–26°C) within 6 h after blood collection, and then stored at -20°C until analyzed. Plasma vitamin B-12 was measured by the microparticle enzyme immunoassay method using a commercial kit (Abbott Laboratory, IMx-B-12, Abbott Park, IL). Retinol was measured using high pressure liquid chromatography as previously reported by Bieri et al. (1979).

The research proposal was approved by the Ethical Review Committee of the Regional SEAMEO-TROPMED Center for Community Nutrition at the University of Indonesia, Jakarta, and conformed to the International Guidelines for Ethical Review of Epidemiological Studies (CIOMS 1991)

The following cut-off points were taken to indicate a deficient situation. Anemia was indicated by hemoglobin values < 120 g/L in females and <130 g/L in males (WHO 1994). Low vitamin A status was indicated by a serum retinol concentration of <0.70 μmol/L. Low thiamine status was indicated by a TPP-induced increase in ETK activity of >25% (Brin 1967). Deficient folate status was indicated by an erythrocyte folate concentration of <368 nmol/L. Vitamin B-12 deficiency was indicated by a serum vitamin B-12 concentration of <148 pmol/L (Herbert 1987).

Statistical analysis. The concentrations of plasma vitamin B-12, red blood cell folate and stimulated ETK activity did not resemble a normal distribution. Normalization was obtained after performing log transformation procedures for vitamin B-12 and folate, and a square root transformation for ETK. Differences in concentration of biochemical indicators between subgroups were investigated using unpaired t-tests. Analysis of determinants of micronutrient status was carried out using stepwise multiple regression, with transformed values if necessary. BMI, age, nutrient intake and dummy variables for sex, smoking, and usage of vitamin or mineral supplements were included as possible determinants.

RESULTS

Selected characteristics of the subjects are presented in **Table 1**. Female subjects were more often widowed (P < 0.001) than male subjects, and they had a lower level of education than men (P < 0.001). More men than women were employed (P < 0.05). The daily meal pattern was similar in men and women, and 25% of subjects reported taking vitamin/mineral supplements on a regular basis. Smoking was more frequent (P < 0.001) among men than women. The mean size of the households to which the subjects belonged was 6.0 ± 3.5, and on average two of these members were working. Nine subjects were living alone. The overall health condition of the subjects was relatively poor, with 58.3% reporting that they suffered from disease(s), and 27.7% reporting having

TABLE 1

Socioeconomic characteristics, health condition, food habits and lifestyles and physical characteristics of urban Indonesian elderly people

	Total (n = 204)	Male (n = 93)	Female (n = 111)
Socioeconomic characteristics			
Widowed, %	42.6	9.67	70.3*
Years of schooling, %			
<3	58.3	30.1	82.0*
3–6	31.9	50.5	16.2
>6	9.8	19.4	1.8
Employed, %	27.9	34.4	22.5#
Health condition, %			
Have diseases[1]	58.3	55.9	60.4
Take medication[2]	40.7	63.4	55.9
Food habits and lifestyles, %			
Take supplements[3]	25.0	24.7	25.2
Smoke	36.8	63.4	14.4*
3-meal pattern	53.4	57.0	50.5
Physical characteristics[4]			
Age, y	66.0 ± 4.3	66.3 ± 4.1	65.8 ± 4.5
Body weight, kg	48.5 ± 10.5	52.1 ± 10.6	45.5 ± 9.5*
Stature, cm	151.8 ± 8.7	158.5 ± 6.2	146.0 ± 5.8*
Armspan, cm	155.5 ± 9.5	162.1 ± 6.9	149.9 ± 7.6*
Stature/armspan ratio	0.98 ± 0.03	0.98 ± 0.02	0.97 ± 0.03
BMI[5], kg/m²	21.0 ± 3.9	20.7 ± 3.6	21.3 ± 4.0
Sum of skinfolds[6], mm	42.8 ± 18.2	37.4 ± 15.2	47.3 ± 19.2*

* Significant difference between gender at $P < 0.001$ (t-test).

\# Significant difference between gender at $P < 0.05$ (t-test).

[1] The three leading self-reported diseases were rheumatism (26.4%), hypertension (15.7%) and bronchial asthma (8.3%).

[2] Medications prescribed by the health care providers according to self-reported diseases.

[3] Vitamins and minerals taken orally.

[4] Values are means ± SD.

[5] BMI, body mass index, was calculated as body weight (kg) divided by height (m), squared.

[6] Sum of 4 skinfold thicknesses (biceps, triceps, subscapular and suprailiac).

more than one disease. Rheumatism, hypertension and asthma were the three leading self-reported diseases.

Mean age did not differ in men and women. Men were significantly heavier and taller than women ($P < 0.001$), but body mass index did not differ significantly between men and women. The overall prevalence of BMI < 18.5 kg/m² was 26.6%, and 14.7% had a BMI < 17.0 kg/m². Overweight, as defined by a BMI > 25.0 kg/m², occurred in 12.3% of the subjects. No significant gender differences existed for the prevalence of low or high BMI. There were positive associations between BMI and sum of skinfolds in men ($r_s = 0.85$, $P < 0.001$) and women ($r_s = 0.72$, $P < 0.001$).

Habitual daily dietary intake of selected nutrients was assessed by the semi-quantitative food frequency questionnaire. The median energy intake was lower than the recommended intake. The median intake of thiamine was less than half of the recommended daily intake of 1.2 mg. The median iron intake of males and females was higher than that of the basal iron requirement of 9–10 mg/d, assuming an intermediate bioavailability of the dietary iron becuase of the relatively high vitamin C intake. The median intakes of vitamins A and B-12 for both men and women were higher than the recommended intakes, but the median folate intake of the men was lower than the recommended intake (**Table 2**). Energy intake was

weakly but significantly correlated with BMI ($r = 0.231$, $P = 0.001$) and the sum of skinfolds ($r = 0.157$, $P = 0.02$). Subjects with BMI < 18.5 kg/m² had mean energy intake of 1306 ± 374 kcal (5459 ± 1563 kJ), whereas subjects with BMI ≥ 18.5 kg/m² had mean energy intake of 1417 ± 502 kcal (5923 ± 2098 kJ).

Biochemical indices of micronutrient status are presented in **Table 3**. Women had lower concentrations of hemoglobin ($P < 0.001$) and plasma retinol ($P < 0.05$) than men. However, men had a lower concentration of erythrocyte folate ($P < 0.001$) than women. No significant difference between men and women in stimulated ETK activity was observed ($P = 0.08$). Thiamine deficiency was most prevalent, with 36.6% of subjects having a TPP effect of >25%. Anemia was also common, as indicated by a low hemoglobin concentration in ~25% of the men and 32% of the women. Using 148 pmol/L as a cut-off-point, vitamin B-12 deficiency occurred in 8.8% of the subjects, and the prevalence of this deficiency was higher in women (11.7%) than in men (3.2%). A higher cut-off-point of 258 pmol/L for diagnosing vitamin B-12 deficiency in the elderly has also been suggested (Allen and Casterline 1994, Lindenbaum et al. 1994). Using this cut-off point, the prevalence of vitamin B-12 deficiency was 32.4% in the whole population, with 33.3 and 31.5% for men and women, respectively. Red blood cell folate concentration was correlated with serum vitamin B-12 concentration ($r = 0.2472$, $P < 0.001$). Other biochemical variables were not significantly correlated with each other.

Stepwise, linear, multiple regression was used to investigate which indices were the major determinants of micronutrient status. Micronutrient intake, age, gender, BMI, supplement use and smoking as well as blood values of other associated micronutrients were included in the model.

Variation in ETK activity (transformed values) was partly explained by the dietary thiamine intake ($r = 0.176$, $P = 0.012$). Variation in plasma retinol concentration was explained ($r = 0.379$, $P < 0.001$) by the dietary vitamin A intake ($P = 0.001$), sex ($P = 0.03$) and BMI ($P = 0.002$).

To investigate possible determinants of hemoglobin concentration, plasma retinol, vitamin B-12 and folate intakes were also added in the model. The model showed that hemoglobin concentration ($r = 0.394$, $P = 0.001$) was determined by sex ($P < 0.001$) and vitamin B-12 intake ($P = 0.003$). Dietary folate intake and erythrocyte folate concentration explained the variation in B-12 concentration ($r = 0.77$, $P < 0.001$). The determinants of erythrocyte folate concentration were sex ($P = 0.003$), BMI ($P = 0.006$) and plasma vitamin B-12 concentration ($P < 0.001$, $r = 0.372$). No significant differences in erythrocyte folate were found between smokers and non-smokers.

DISCUSSION

The investigated subjects were not representative of the whole elderly population of Jakarta. However, the study provided information on the nutritional status of apparently healthy (mentally and physically), free-living elderly individuals living in a poor urban area of Jakarta. Life expectancy at birth in Indonesia was 63 y in 1993 (World Bank 1995). The average age of the investigated subjects was 66 y, which is higher than the life expectancy. Therefore the subjects can be considered as elderly in the Indonesian context.

In the present study, nutritional status was assessed by anthropometric and biochemical indicators, as well as by the intake of selected nutrients. Although no specific studies were undertaken in the Indonesian elderly to test the validity of

TABLE 2

Habitual energy, protein, fat, thiamine, vitamin B-12, folic acid, vitamin C, vitamin A and iron intakes of urban Indonesian elderly people

Nutrient	Male (n = 93)		Female (n = 111)	
	Median intake (P25–P75)	Reference value[1,2]	Median intake (P25–P75)	Reference value
Energy, *kcal*	1416 (1120–1739)	1772	1251 (989–1521)	1571
kJ	5922 (5016–7269)	7414	5229 (4133–6358)	6573
Energy, *kJ/kg BW*	118.3 (93.2–140.0)		118.9 (91.8–147.4)	
Protein, *g*	43.2 (34.2–50.3)	43.4	37.6 (30.1–48.1)	37.9
Fat, *g*	22.1 (15.5–32.0)	23.6	20.9 (14.1–33.0)	20.9
Thiamine, *mg*	0.52 (0.40–0.60)	1.2	0.44 (0.40–0.60)	1.2
Vitamin B-12, *μg*	3.49 (2.0–5.9)	1.0	3.0 (1.7–5.7)	1.0
Folic acid, *μg*	187.1 (145.5–241.2)	200	177.1 (129.0–213.4)	170
Vitamin C, *mg*	72.6 (47.6–125.0)	30	69.4 (39.1–98.6)	30
Vitamin A, *μg RE*	1005.3 (629.8–1609.1)	600	860.0 (474.8–1373.4)	500
Iron, *mg*	13.0 (10.4–16.3)	10	12.7 (9.9–17.5)	9

[1] Reference value for energy intake is based on an activity pattern, which is equal to 1.5 times BMR. The BMR is calculated using the mean weights and heights and the equations of WHO (1985). Calculation of reference value for protein intake is based on a digestibility relative to meat of 0.9 and the WHO (1985) recommendations. Calculation of reference value for fat intake is based on the recommendation that ≥15% of energy intake should be provided by fat (WHO, 1990). Reference values for vitamin A, folate and vitamin B-12 are based on safe levels recommended by FAO/WHO (1988). Reference value for iron is based on median basal requirement on intermediate bioavailability diet recommended by FAO/WHO (1988).

[2] BMR, basal metabolic rate; BW, body weight; RE, retinol equivalent.

food intake assessed by the food frequency questionnaire, we decided to adopt this method because it was recommended and applied by other two cross-cultural studies in elderly populations (Gross 1997, Wahlqvist et al. 1995a).

By using different indicators, we classified a large part of the investigated subjects as being malnourished. The overall prevalence of chronic energy deficiency, as indicated by a BMI < 18.5 kg/m² (James et al. 1988), was 26.6%. Low BMI values in the Asian elderly population were also reported in the IUNS Study (Roche 1995). The BMI values of elderly men and women in the present study were not different from the Chinese elderly men and women, aged 70–79 y, living in rural Tianjin and were similar to BMI values of the Guatemalan elderly (King et al. 1997).

Recently, Rabe et al. (1996) studied 69 elderly subjects, aged 60–69, living in a low-income area in Central Jakarta. They found that ~30% of the subjects were considered chronically energy deficient. However, the BMI values presented in our study are higher than those reported for a group of institutionalized elderly Indonesian individuals (18.2 ± 2.4 kg/m² for males and 18.2 ± 3.8 kg/m² for females) (Oenzil 1995). The fact that the BMI values had substantial degrees of agreement with skinfold measures of fatness in the present study has supported the previous findings (Iswarawanti et al. 1996, Rabe et al. 1996).

The assessed food consumption indicated that only the median intakes of energy and thiamine were less than the recommended daily intake. The low intake of energy corre-

TABLE 3

Hemoglobin, plasma retinol, red blood cell folic acid and plasma vitamin B-12 concentrations and erythrocyte transketolase stimulation of urban Indonesian elderly people[1]

Biochemical indices	Total	Male (n = 93)[2]	Female (n = 111)
Hemoglobin,* *g/L*	136 ± 24	145 ± 23	129 ± 22
Low status,[3] %	28.9	24.7	32.5
Plasma retinol,# *μmol/L*	1.30 ± 0.35	1.37 ± 0.37	1.26 ± 0.33
Low status, %	5.4	4.3	6.3
RBC folic acid,* *nmol/L*	653 ± 232 (621)	600 ± 196 (573)[4]	697 ± 251 (664)
Low status, %	2.9	5.4	0.9
Plasma vitamin B-12, *pmol/L*	371 ± 207 (435)	371 ± 200 (441)	372 ± 213 (431)
Low status, %	8.8	3.2	11.7
ETK[5] stimulation, %	21.3 ± 17.7 (17.5)	24.0 ± 19.8 (19.7)	19.0 ± 5.3 (15.7)
Low status, %	36.6	42.4	31.7

* Significant difference between genders at $P < 0.001$ (*t*-test).

\# Significant difference between genders at $P < 0.05$ (*t*-test).

[1] Values are expressed in mean ± SD.

[2] n = 92 men for retinol and ETK; n = 110 women for ETK.

[3] Low status: Hb <130 g/L (for men), Hb < 120 g/L (for women); retinol < 0.70 μmol/L; folate < 368 nmol/L; B-12 < 148 pmol/L; ETK stimulation > 25%.

[4] Untransformed values are presented; geometric means in parenthesis.

[5] RBC, red blood cell; ETK, erythrocyte transketolase.

lated positively with BMI and with fat mass. The intakes of the other vitamins were assessed as being relatively favorable. The median vitamin A intake seemed to be adequate and exceeded the US revised RDAs of 1000 μg retinol equivalent (RE) for males and 800 μg RE for females for people aged $\geq$ 51 y (National Research Council 1989). About 8% of the males and 14% of the females had vitamin A intakes below two-thirds of the recommended dietary intake (RDI). In the SENECA study, >50% of the European elderly in three towns were identified as having vitamin A intakes below the lowest European RDI, which are 700 μg for males and 600 μg for females (Euronut SENECA Investigators 1991a and b).

The adequacy of vitamin A intakes in this population was generally reflected in the relatively high plasma retinol concentrations, and a weak, but significant, correlation existed between plasma retinol and vitamin A intake. However, the subjects who had an intake of >400 RE had an average plasma retinol concentration of 1.23 μmol/L, indicating that assessed low intake was a poor predictor of biochemical status. A similar lack of agreement between assessed vitamin A intake and plasma retinol concentration was also reported for the European elderly. Results of the SENECA study revealed that there was nil prevalence of biochemical vitamin A deficiency despite the application of lower cut-off for plasma retinol concentration (<0.35 mol/L) to define high risk of vitamin A deficiency (Euronut SENECA Investigators 1996a).

This study showed that the median thiamine intake of the elderly was about 50 and 45% of the RDI for males and the females, respectively. About 93% of the men and 80% of the women had thiamine intakes below two-thirds of the RDI. These values are particularly high in comparison with other elderly nutrition studies. In the IUNS study (Wahlqvist et al. 1995b) the Asian elderly, who were mostly Chinese and Japanese, were similar to the Greeks in Melbourne, with 10–20% not achieving the RDA. It is plausible that the Chinese and Japanese elderly obtain thiamine by consuming large quantities of rice. However, the Indonesian elderly were not able to satisfy their thiamine requirements despite rice being a staple food. Most Indonesian people, nowadays, consume machine-milled rice, which is distributed by the Indonesian government. The polished rice has a lower thiamine content than the unpolished rice (0.134 mg/100 g rice vs. 0.320 mg/100 g rice, respectively) (Djoenaidi 1991). In the SENECA study, about 20% of the men and 30% of the women were not achieving the lowest European RDA for thiamine (0.8 mg/d for men and 0.7 mg/d for women) (Euronut SENECA Investigators 1991b).

The low intake of thiamine in our study was confirmed by a high prevalence of the subjects having ETK > 25%, ~42% in the men and 32% in the women. These values are much higher than a Boston survey (Sokoll and Morrow 1992) where ~15% of the elderly subjects had marginal thiamine status, and 2–5% were deficient. Using a clinical indicator, Djoenaidi (1991) reported that the incidence of beriberi polyneuropathy in young adults was ~4% of total admissions in the Neurological Department at the Dr. Soetomo Hospital in Surabaya.

The median vitamin B-12 intake of the subjects was higher than the USA RDA (National Research Council 1989) (2 μg for men and 1.6 μg for women). About 2% of the men and 3% of the women had dietary vitamin B-12 intakes below two-thirds of RDI. Using 148 pmol/L as a cut-off-point, ~3% of the male subjects and 12% of the female subjects in this study were considered to have vitamin B-12 deficiency. In the IUNS study (Wahlqvist et al. 1995b), a different cut-off-point, ie 111 pmol/L, was used. With this cut-off, 2–8% of the assessed elderly populations (Spata Greeks, Melbourne Greeks, Swedes

and Anglo-Celtics) had vitamin B-12 deficiency. In the SENECA study, 2.7% of the elderly subjects had low plasma vitamin B-12 concentrations (<111 pmol/L) (Euronut SENECA Investigators 1991a). This value increased to 7.3% in the SENECA's follow-up study (SENECA Investigators 1996a). There is growing evidence to indicate that in the elderly with vitamin B-12 deficiency, neuropsychiatric and metabolic abnormalities may precede megaloblastic anemia (Allen et al. 1993, Lindenbaum et al. 1988). Using a metabolic study, Lindenbaum et al. (1994) demonstrated that the cut-off-point of <148 pmol/L to define vitamin B-12 deficiency in the elderly was too low. They proposed that a serum vitamin B-12 concentration < 258 pmol/L is a better cut-off for suspecting vitamin B-12 deficiency. We found that 32.4% of the subjects would be deficient when using this cut-off. In the Framingham study, the prevalence of vitamin B-12 deficiency among the elderly was 40.5% (Lindenbaum et al. 1994).

The median folate intake of the subjects in this study was lower than the USA RDA (National Research Council 1989) of 200 μg for males and 180 μg for females, and ~20% of males and females had folate intakes below two-thirds of the RDI. This value is about three times that found in the Boston survey (Sahyoun 1992).

In spite of the low intakes, only 5% of the men and 1% of the women had RBC folate below 368 nmol/L. In the IUNS study, the mean plasma folate concentration in the Caucasian elderly was above the minimum cut-off of 6.8 nmol/L. Folate status appeared to be good in most of the four assessed elderly populations (Spata Greeks, Melbourne Greeks, Swedes, and Anglo-Celtics), with <5% having values below this cut off (Wahlqvist et al. 1995b). Similarly, in the SENECA study, folate status was good in all individuals in all centers.

No subjects were at risk of folate deficiency with blood concentrations below 6.8 nmol/L (Euronut SENECA Investigators 1991a). The prevalence of folate deficiency increased from 0 to 0.3% among the elderly subjects in the SENECA follow-up study (SENECA Investigators 1996a).

It can be concluded that malnutrition was quite common among the investigated population, which stresses the need for specific interventions. Irrespective of the assumptions made in the nutrient analyses, it was clear that the Indonesian elderly had less favorable thiamine status than their counterparts living in developed countries. Moreover, dietary thiamine intakes of this population group were not as good as their Asian counterparts, namely Chinese and Japanese. To what extent the thiamine status of this population causes any clinical signs and symptoms would await more comprehensive clinical studies. Using the cut-off proposed by Lindenbaum et al. (1994), the prevalence of vitamin B-12 deficiency in this study does not differ much from the other available studies, and the eventual consequences of a deficient status would need to be further investigated. Anemia was prevalent among the Indonesian elderly, and although the hemoglobin concentration was associated with vitamin B-12 intake, no observation was made with respect to the type of anemia in this study. It would be of interest to observe the association between vitamin B-12 and folate status and their endpoints in this population in the near future as far as megaloblastic anemia and other metabolic abnormalities are concerned.

Micronutrient supplementation would be a possibility to improve the micronutrient status of the elderly. The composition of the supplement would, however, need to reflect the deficient status of thiamine and vitamin B-12, and it would need to be investigated whether supplementation with iron would improve hemoglobin concentration.

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