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A STUDY ON THE FOOD AND NUTRITIONAL STATUS OF THE ARMED FORCES

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SUMMARY

The nutritional status of 158 soldiers drawn from four army camps in Selangor, Negeri Sembilan and Pahang has been assessed by biochemical procedures, nutritional anthropometry and dietary (chemical) analysis.

Biochemical assessment showed that with the exception of thiamin and riboflavin nutriture, the nutritional status of the soldiers appeared generally satisfactory and seemed to have improved slightly over those examined by the Inter-Departmental Committee on Nutrition and National Defence (ICNND), U.S.A., in 1962 [1] *by similar methods.*

The anthropometric assessment indicated that the present day soldiers have the same mean height as those examined in 1962. Although they appeared slightly heavier, obesity did not seem to be a problem.

Chemical analysis of their diet showed that there is room for improvement in the dietary supply of vitamin A and some of the water-soluble vitamins, particularly riboflavin, thiamin and vitamin C.

There was also a significant discrepancy between the nutritional content of the chemically-analysed cooked meals and those calculated from the ration scales using Food Composition Tables, suggesting a need to review the current system of food supply, preparation and food service within army camps in Malaysia.

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INTRODUCTION

It has been said that 'the army fights on its belly' and food supplies rank equally with the supply of ammunition and gasoline. A modern army however should not only be provided with adequate and reasonably palatable food but also one of sound nutritional quality.

Several previous studies have been made on the food and nutritional status of the Malaysian Armed Forces, the most comprehensive of which was the one conducted by the ICNND, U.S.A. [1] In 1973, the nutritional quality of combat rations obtained by chemical analysis was reported [2] and recently Quah [3] reviewed the nutritional adequacy of the Malaysian Armed Forces rations.

The present paper presents the biochemical assessment on the nutritional status of 158 soldiers of the Royal Malay Regiment drawn from 4 different barracks, namely, Sungai Besi, Kuala Kubu Bharu, Bentong and Seremban and examines this against the nutritive quality of the cooked rations issued from two of these camps.

The present data arising from a study conducted in 1979, [4] are also examined in relation to the ICNND study, [1] the army anthropometric study of 1976 [5] and the report by Quah [3]

MATERIALS AND METHODS

All the soldiers were of the Malay race and their ages ranged from 20-40 with a mean age of 28.6 years.

Nutritional Anthropometry

Weight and height were measured on a SECA adult beam balance with a height attachment. Weight was measured to the nearest 0.1 kg and height to the nearest 0.5 cm with the subjects in barefeet and shorts.

Nutritional Biochemistry

12 mls of blood were obtained by venipuncture from every subject and were distributed into an EDTA and a plain bottle for the determination of haemoglobin, micro-haematocrit, vitamin A, transketolase activity, serum protein, albumin, globulin fractions, serum iron, iron binding capacity, serum cholesterol, triglycerides, beta-lipoproteins and high density lipoprotein cholesterol. A casual urine sample was also collected into a 30 ml screw-capped bottle containing dilute HCl for determination of thiamin, riboflavin and creatinine.

Guidelines for Interpretation of Blood Data

Unless otherwise stated, the guidelines used were those recommended by the ICNND [6] or those by Sauberlich *et al.* [7]

Chemical Analyses of Cooked Meals

All the food served to one soldier for a day was collected over three consecutive days from one camp (Sungai Besi) and for two consecutive days from another camp (Seremban).

After separating inedible portions such as bones, the meals from the two camps were separately pooled and blended and the breakfasts, lunches, dinners and snacks were analysed for the following : moisture, ash, protein, fat, carbohydrate (by difference) thiamin, riboflavin, vitamin A, vitamin C, niacin, calcium and iron.

RESULTS

NUTRITIONAL BIOCHEMISTRY

Protein Status

The protein status (Table I) of the 158 men examined was extremely satisfactory and seemed superior to 123 men assessed by the ICNND. [1] None of the present subjects had a total protein of less than 6.0 g/dl serum or albumin value of less than 3.5 g/dl serum. According to the aforementioned criteria, no man could be classified as 'high' risk or 'medium' risk with respect to protein status.

Of 158 subjects, 26 or 16 percent had raised gamma-globulin levels in excess of 1.7 g/dl serum. This compares with a prevalence rate of 11 percent found for 120 Shah Alam factory workers reported in 1977. [8]

TABLE I
PROTEIN STATUS
(Mean and standard errors)
IN g PER dl SERUM

	Present Study n = 158	ICNND (1964) n = 123
Total Serum Protein	7.5 ± 0.03	7.3 ± 0.05
Serum albumin	4.8 ± 0.03	4.0 ± 0.04
$Alpha_1$-globulin	0.2	
$Alpha_2$-globulin	0.4	3.3 ± 0.06
Beta-globulin	0.7	(total globulin)
Gamma-globulin	1.4 ± 0.03	
A/G ratio	1.8	1.3

Vitamin A Status

The vitamin A status of the subjects was very satisfactory and again appeared better than the series examined by the ICNND. [1] Out of 158 subjects, 91 or 58 percent had vitamin A values that are regarded as 'high' (i.e. > 50 μg/dl) while only one person had a value that is regarded 'low' (i.e. < 20 μg/dl) - Table II.

Thiamin Status

The functional test of measuring erythrocyte transketolase activity for assessing thiamin status showed that 46 out of 158 men had % TPP effect exceeding 25, suggesting that 29 percent of the subjects examined had a deficient thiamin status (Table II). This observation is corroborated by the urinary thiamin excretion as 30 percent of the men

TABLE II
VITAMIN A, THIAMIN & RIBOFLAVIN STATUS
(Mean And Standard Errors)

	Present Study n = 158	ICNND -1964 n = 120
Serum Vitamin A μg per dl	53 ± 1.1	45 ± 1.2
R.B.C. transketolase activity in I.U.	57 ± 1.04	not done
% T.P.P. effect	19 ± 1.6	not done
Urine thiamin μg/g creatinine	*70	*52
Urine riboflavin μg/g creatinine	*77	*32

* Median values

showed 'medium risk' on the basis of urinary thiamin excretion of less than 66 μg/g creatinine. Despite this, the status of thiamin nutrition seems better now than the 1962 series when it was found that 64 percent of the subjects had 'medium risk' urinary thiamin values.

Riboflavin Status

The riboflavin status was unsatisfactory in 51 percent of the subjects on the basis of an excretion value of $<$ 80 μg/g creatinine, corresponding to 'medium risk'. However only 5 percent of the subjects may be classified as 'high risk' on the basis of excretion value of $<$ 27 μg/g creatinine (Table II). Riboflavin status seems only to have improved slightly from 1962 [1] when 83 percent of the subjects examined then were classified in the 'medium risk' category.

Iron Status

On the basis of haemoglobin values of $<$ 12 g/dl and haematocrit of $<$ 37 percent, none of the subjects could be classified as anaemic (Table III). However, the serum iron study revealed that 16 percent (26 out of 156) of subjects had 'low' levels ($<$ 60 μg/dl) while 15 percent (24 out of 156) had a transferrin saturation of less than 20 percent.

The mean haemoglobin and haematocrit values of the present series do not seem to differ from those examined by the ICNND. [1]

Serum Lipids

The mean cholesterol level was 199 mg/dl (Table IV) which is significantly higher than the mean value of 180 mg/dl reported by the ICNND [1] ($p < 0.001$). A total of 9 out of 158 soldiers or 6 percent may be regarded as hypercholesterolaemic using cut-offs in excess of 250 mg/dl and 270 mg/dl as indicative of hypercholesterolaemia for the age group 20-29 years and 30-39 years respectively. The mean level of cholesterol and the above prevalence for hypercholesterolaemia are closely similar to those found for a group of urban Malays reported in 1975. [9]

TABLE III
IRON STATUS
(Mean And Standard Errors)

	Present Study n = 158	ICNND-1964 n = 125
Haemoglobin g per dl	15.8 ± 0.09	15.7 ± 0.14
PCV %	48 ± 0.21	45 ± 0.29
MCHC %	33	35 ± 0.25
Serum Iron μg per dl	88 ± 2.4	Not done
TIBC μg per dl	297 ± 4.9	Not done
% Transferrin saturation	30 ± 0.85	Not done

TABLE IV
SERUM LIPIDS
(Means And Standard Errors)

	Present Study n = 158	ICNND-1964 n = 121
Cholesterol mg per dl	199 ± 3.1	180 ± 4.0
Triglycerides (non-fasting) mg per dl	168 ± 6.4	Not done
HDL-chol mg per dl	45 ± 0.84	Not done
Beta-lipoproteins mg per dl	523 ± 18.6	Not done
Mean Age (years)	29	26

The non-fasting triglycerides levels (Table IV) are comparable to a non-fasting series reported earlier in 1971. [10]

High Density Lipoprotein Cholesterol (HDL-chol)

The mean HDL-chol of the soldiers was 45

TABLE V
WEIGHT, HEIGHT, AND BODY MASS INDEX
(Means and Standard Deviations)

	Mean Age Years	Weight kg	Height cm	Weight/ Height^2 (kg/m^2)
Present study n = 158	28.6 ± 5.3	60.5 ± 7.7	165 ± 4.9	22.2 ± 2.45
ICNND[1] n = 1268	25.9	57.9	165.5	21.1
Army Anthropometric Survey [5] n = 1854	26 - 30	58.6 ± 7.9	164 ± 3.5	21.8

mg/dl. This mean value is closely identical to the mean of a larger series of healthy male Malaysians reported by Chong *et al.* [11]

Nutritional Anthropometry

Table V shows the weight, height and the body mass index (Wt/Ht^2, where weight is in kg and height in metres) of the present subjects. They are slightly heavier in terms of the body mass index than the series in 1962 and are more similar than those reported in the army anthropometric survey of 1976. [5]

Eleven percent of the subjects (or 17/158) may be regarded as overweight or obese taking the body mass index of > 25.0 as indicative of obesity. [12] This appears to be similar in prevalence to the overall rate of 10 percent derived from the data of Khoo *et al.* [5]

In contrast, the number of men who could be regarded as underweight (body mass index of < 20) was 15 percent or 24/158 compared to a prevalence rate of about 19 percent in 5817 men for the age group 19-40 years reported in 1976. [5]

Nutritional Indicators By Age

Table VI shows that subjects less than 30 years old appeared slightly taller and lighter than older subjects above 30 years. However this difference was not statistically significant. There was also a tendency for the serum lipids and beta-lipoproteins to rise with age although this effect was not evident for HDL-chol.

Chemical Evaluation of Army Diet

The daily per capita intake of nutrients from the two camps obtained by chemical analysis is shown in Table VII. From this Table, it would seem that the calorie, protein, and fat content of the present diet are slightly lower than the corresponding values obtained in 1962. However taking into account that rice consumption was *ad libitum* and snack foods were not available for analysis from one camp, the difference would seem to be more apparent than real. The proportions of calories from protein, fat and carbohydrate sources, viz, 14%, 20% and 67% respectively have however remained unchanged since 1962.

The dietary thiamin, and niacin values are within the range recommended by the ICNND, although there is obvious room for the intake of these to be further improved.

The vitamin C content of the diet appeared deplorably low. Clearly its supply depends on the amount and the type of fruits served. Common Malaysian fruits vary considerably in their content of vitamin C, e.g. relatively lower in bananas, pineapples and watermelons compared to papaya, starfruits and rambutans. The small servings of the first category of fruits, viz., pineapple and watermelon on the days when the meals were sampled for analysis may partly explain the low levels of vitamin C found.

TABLE VI
ANTHROPOMETRIC INDICATORS AND SERUM LIPIDS BY AGE
(Means And Standard Deviations)

Age Group	No. of Subjects	Weight kg	Height cm	O.I. Wt/Ht^2	T.C. mg/dl	T.G. mg/dl	HDL-chol mg/dl
20 - 25 years	42	57.9 ± 5.0	166.2 ± 4.9	21.0 ± 1.4	192 ±39	137 ± 58	45 ± 10.6
25 - 30 years	49	60.9 ± 7.3	166.3 ± 4.6	22.0 ± 1.3	190 ± 29	155 ± 57	49 ± 11.6
30 - 35 years	41	62.2 ± 9.4	164.6 ± 5.7	22.9 ± 2.9	193 ± 34	167 ± 82	41 ± 8.5
35 - 40 Years	24	61.2 ± 6.4	163.5 ± 3.8	22.9 ± 2.6	227 ± 49	182 ± 128	43 ± 9.0
> 40 years	2	63.4 ± 11.4	163.2 ± 0.1	23.8 ± 4.2	229 ± 124	193 ± 124	43 ± 8.5

TABLE VII
DAILY PER CAPITA NUTRIENT INTAKE
(Chemical Analysis)

	Sungai Besi Camp	Serem-ban Camp	ICNND 1962	Acceptable ICNND 1962
Calories	2793	2187	2827	2800 - 3000
Protein g	88	63	98	60 - 90
	* (14%)	(12%)	(14%)	
Fat g	57	49	59	-
	* (20%)	(20%)	(19%)	
Carbohydrate g	469	374	477	-
	* (67%)	(68%)	(67%)	
Calcium mg	736	735	463	400 - 800
Iron mg	27	34	26	9 - 12
Vitamin A I.U	600	600	1850	3500 - 5000
Riboflavin mg	1.0	0.9	1.1	1.2 - 1.5
Thiamin mg	1.9	1.1	0.6	1 - 1.5
Niacin mg	11	-	17	10 - 15
Vitamin C mg	trace	trace	24	30 - 50

* Figures in parentheses refer to percent of total calories

DISCUSSION

The present assessment of the nutritional status of soldiers from four camps have not shown up any serious problems of nutritional deficiencies. This is generally similar to the conclusions of a previous survey conducted on the Malaysian armed forces conducted by the ICNND. [1]

The status of protein, vitamin A, thiamin and riboflavin nutriture seemed to have improved slightly over the 1962 series, although there is obviously room for further improvement with regard to thiamin and riboflavin nutriture. The prevalence of hyper-gamma-globulinaemia presumably reflects the presence of infections and parasitism. Although the rate of 16 percent seemed slightly higher than that observed (10 percent) for a group of Shah Alam factory workers, [8] it is low in comparison with the high rates of 48-70 percent found in Orang Asli in the jungles. [4] Serum iron studies revealed some mild prevalence for iron deficiency which was not evident on the basis of haemoglobin levels.

There was a tendency for serum cholesterol, triglycerides and beta-lipoproteins to rise with age but this association with age did not apply to the level of HDL-chol. The mean level of cholesterol in the present soldiers is higher that the mean value for soldiers in the same age group of 1962 by 18 mg per 100ml. The current dietary fat intake is not high and amounts to 20 percent of the total calories, essentially unchanged from the value reported during 1962. Thus, factors other than dietary fat must be sought to explain these soldiers' cholesterol levels which now approach those reported for a group of urban Malays in the same age group. [9]

At first glance, the results arising from the chemical analysis of the soldiers' diet indicate some calorie deficit especially in meals provided at the Seremban camp. However this calorie deficit may not be real as rice consumption was not at all restrictive and on the days when food was sampled for analysis at the Seremban camp, snack foods were not served.

The low level of vitamin C in the meals analysed suggests that the quantity of fruits served could be raised or that common fruits known to be richer sources of vitamin C such as papaya and starfruits should be featured more frequently in the diet.

Despite the conflicting evidence on the status of thiamin and riboflavin arising from the biochemical assessment and diet analysis, there are good nutritional grounds to ensure a regular supply of legumes, groundnuts and bean sprouts as sources of thiamin and the various dark green leafy vegetables as a source of riboflavin (as well as beta-carotene).

There has been some concern that obesity may be a problem in the armed forces. [3] This may seem unfounded in the present study as the percentage of underweight soldiers (15 percent) were in excess over those considered overweight (11 percent). Obesity was however associated with the serum triglycerides levels as there was a positive correlation between the latter and the body mass index ($r = 0.37$, $p < 0.001$, $n = 158$).

The nutrititive quality of the present army ration scales which have not been modified for many years has been calculated previously [3] using a Food Composition Table. The present study shows a significant gap in the nutritive content between the chemically-analysed values and those computed by Quah, viz :-

	Calories	Protein g	Fat g
Quah (1977)	4,096	99	138
Present study (chemical analysis)	2,793	88	57

The above discrepancy suggests a need for a re-appraisal of the current status of the tendering, supply, preparation and the serving of food in army camps. This would serve not only to ensure a continued supply of nutritive meals but may also assist in the further improvement of the overall quality of the diet of our armed forces.

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