

# Coronary Risk Factors of Male Workers on a Kauai, Hawaii, Plantation

DARWIN R. LABARTHE, M.D., M.P.H., PETER M. KIM, M.D., and S. PAUL EHRLICH, Jr., M.D., M.P.H.

**T**HE RELATIONSHIP of certain physiological and biochemical factors to the occurrence of coronary heart disease (CHD) has been well documented in several epidemiologic studies conducted in the continental United States. Prospective, retrospective, and cross-sectional studies all have demonstrated associations between the occurrence of CHD and blood pressure levels, serum uric acid, and cholesterol concentration levels, relative overweight, and certain electrocardiographic abnormalities.

Are there universal relationships between these factors and the risk of CHD? Keys and co-workers (1) and Epstein (2), among others, present evidence for a wide variation in the distributions of these factors among distinct populations. This variation affords important opportunities to assess the consistency of the relationships of these factors to the occurrence of CHD. Of particular interest has been the variation of risk factor distributions among populations geographically dispersed, but sharing a relatively homogeneous genetic background, or genetically distinct, but sharing a common geographic location. Examples of both types of variation are reported by Keys and co-workers (1). The significance of comparisons

of these kinds lies in the possibility of refining our understanding of the operation of the several already recognized risk factors for CHD and of recognizing new factors of risk as well.

On Kauai, northernmost of the principal islands of Hawaii, some of these relationships were studied in a cross-sectional survey among Japanese and Filipino employees of a large sugarcane plantation in 1964. The results of an industrial health examination in this island population permitted comparison of risk factor distributions both between Japanese and Filipino co-workers and also with data for Japanese examined elsewhere by other investigators.

## Methods

The study population included all male employees of the Lihue Plantation Company, Ltd., a large sugarcane plantation in Lihue, Kauai. All employees were eligible for examination. Only a small number of persons were inaccessible or refused examination, and they represented less than 2 percent of the total number of employees. Altogether, 805 persons were examined.

Data are presented only for the 634 Japanese and Filipino employees, because there were too few persons of other ethnic groups to warrant analysis. Racial classification conformed to census procedures of the State of Hawaii. Persons of mixed parentage were allocated to the race of the father, except that if one parent was Hawaiian the children were classified as "part-Hawaiian." Few persons studied were of mixed parentage.

---

*Dr. Labarthe is associate professor of epidemiology, School of Public Health, University of Texas, Houston. Dr. Kim is district health officer, Hawaii Department of Health, Lihue, Kauai, and Dr. Ehrlich is deputy director, Office of International Health, Public Health Service.*

All participants underwent a screening examination which included a medical questionnaire, physical examination, blood pressure determination, electrocardiogram (ECG), and withdrawal of a blood sample. Serum cholesterol concentration levels were determined by the method of Levine and Zak (3), and ECG coding followed the classification scheme of Blackburn and co-workers (4). Statistical analysis employed the Student's *t* test for comparisons of means.

## Results

*Age distribution.* Table 1 shows the age distributions of both the Japanese and Filipino groups of plantation employees who were examined. The Japanese were more evenly distributed by age, in contrast to the Filipinos, where older persons predominated. Within each 5-year age group, however, there was little difference in ages of Japanese and Filipinos as shown by the comparison of group means. For further analysis, therefore, comparisons were made by 5-year age groups whenever possible.

*Sociocultural characteristics.* Information concerning nativity and educational history dis-

closed marked sociocultural differences between Japanese and Filipino employees. Among Japanese, only seven persons (4.1 percent) were born outside Hawaii, all of whom were born in Japan. Among Filipinos, 441 persons (95.9 percent) were born outside Hawaii, all in the Philippine Islands. Data were missing for four persons.

The number of years of formal education was greater among Japanese than among Filipinos in each age group. Increasing age was consistently associated with less formal education for both ethnic groups. Among Japanese, in the youngest age group, no person had completed less than 8 years of school, while for even the youngest Filipinos, 20 persons (66.7 percent) had not completed 8 years of school. Among the oldest persons examined only 13 Japanese (59.1 percent) but 77 Filipinos (97.5 percent) completed less than 8 years of school.

*Blood pressure.* Table 2 shows the mean systolic blood pressures by age group among Japanese and Filipino plantation workers. Little difference appeared between ethnic groups in the distributions of blood pressure by age. The most striking feature of these distributions was the generally progressive increase

**Table 1. Distribution of workers by age and ethnic group**

Age group (years)	Japanese			Filipino		
	Number	Percent	Cumulative percent	Number	Percent	Cumulative percent
35-39	30	17.5	17.5	30	6.5	6.5
40-44	25	14.6	32.1	57	12.3	18.8
45-49	33	19.3	51.4	38	8.2	27.0
50-54	37	21.6	73.0	121	26.1	53.1
55-59	24	14.0	87.0	138	29.8	82.9
60-64	22	12.9	99.9	79	17.1	100.0
Total	171	99.9		463	100.0	

**Table 2. Mean systolic blood pressures by age and ethnic group**

Age group (years)	Japanese			Filipino		
	Number	Mean (mm. Hg)	S.D.	Number	Mean (mm. Hg)	S.D.
35-39	30	130.0	15.0	30	130.7	16.8
40-44	25	135.2	17.7	57	128.8	15.6
45-49	33	137.6	22.6	37	135.0	20.9
50-54	37	140.5	23.8	115	140.1	22.8
55-59	24	144.8	25.5	142	142.3	28.3
60-64	22	149.1	23.9	79	153.5	24.6

in mean blood pressure levels with rising age for both ethnic groups.

In the first three age groups proportionately more Japanese than Filipinos had high blood pressure—values of 160 mm. Hg or greater; in the three older age groups a similar or smaller proportion of Japanese and Filipinos showed these relatively high levels of blood pressure. The results for diastolic blood pressure were closely parallel to those shown for systolic blood pressure.

*Cholesterol.* Table 3 shows a similar analysis of levels of serum cholesterol concentration. Striking differences appeared between the Japanese and the Filipinos in corresponding age categories. The mean cholesterol levels were significantly higher for Japanese than for Filipinos in all age groups, with  $P < 0.50$  or less. Further, separate analysis showed levels of cholesterol concentration of more than 260 mg. per 100 cc. to be significantly more common among Japanese than among Filipinos. In neither ethnic group was any consistent relationship observed between age and cholesterol concentration level.

*Uric acid.* The mean uric acid concentration for each age group of Japanese and Filipinos is

shown in table 4. The levels of uric acid concentration are in general higher among the Filipinos than among the Japanese workers for whom data were available. Twenty-nine percent of each group—50 Japanese and 132 Filipinos—could not be tested because of insufficient serum. These differences were significant at the level of  $P < 0.05$  or less for all ages except 35–39 and 45–49 years.

*Ponderal index.* Ponderal index is defined as the computed ratio of height, in inches, to the cube root of weight, in pounds. The value of this index thus decreases as weight increases in relation to height. Table 5 shows the mean ponderal index for each ethnic group by age.

No consistent differences in the ponderal index occurred between Japanese and Filipinos. Only for persons aged 50–54 was the difference in group means ( $P < 0.005$ ) great enough to show statistical significance at a level of  $P < 0.05$  or less. In neither ethnic group was a consistent age trend noted.

*Physical activity.* Usual physical activity at work was assessed by questionnaire, each person being asked to report his own estimate of physical activity at levels later summarized as heavy, moderate, or light. Because no consistent

**Table 3. Levels of serum chloesterol concentration by age and ethnic group**

Age group (years)	Japanese			Filipino		
	Number	Mean (mg. per 100 cc.)	S.D.	Number	Mean (mg. per 100 cc.)	S.D.
35-39-----	29	242.8	37.5	30	225.1	62.8
40-44-----	25	253.2	57.8	57	219.6	44.0
45-49-----	33	257.1	58.4	38	218.8	41.6
50-54-----	37	248.8	49.7	115	227.1	45.4
55-59-----	24	267.2	51.4	143	222.8	53.3
60-64-----	22	249.6	24.6	79	222.3	49.8

**Table 4. Uric acid concentration by age and ethnic group**

Age group (years)	Japanese			Filipino		
	Number	Mean (mg. per 100 cc.)	S. D.	Number	Mean (mg. per 100 cc.)	S. D.
35-39-----	21	5.7	1.3	22	6.3	1.0
40-44-----	19	5.5	1.6	42	6.2	1.1
45-49-----	28	6.0	1.7	28	5.9	1.6
50-54-----	24	5.3	1.4	80	6.4	1.4
55-59-----	15	5.3	1.5	101	6.4	1.3
60-64-----	14	5.3	1.3	58	6.0	1.3

variation was observed between reported physical activity and age, the data are presented in table 6 with the age groups combined.

While close to one-half of all subjects reported moderate levels of physical activity, a higher proportion of Japanese than Filipinos reported light activity and more Filipinos than Japanese reported heavy activity. Thus, heavy physical activity appeared to be more characteristic of the Filipinos than of the Japanese workers.

*Electrocardiogram.* Electrocardiographic abnormalities were distributed as shown in table 7. Because of the low frequency of the more specific abnormalities, the data are presented for combinations of the 5-year age groups. Thus young Japanese and young Filipinos are those 35-49 years old, and old Japanese and old Filipinos are those workers who were 50-64 years old.

When all reported abnormalities were taken together, no significant difference in their frequency occurred between Japanese and Filipinos in either age category. If those abnormalities alone were considered which indicated myocardial infarction or ischemia (Blackburn's class I, II, and III abnormalities and class VII, excluding nonspecific changes), a significant excess in frequency was noted to occur among older Japanese when compared with older Filipinos, although the number of such cases was small.

*Concurrence of risks.* Determining whether these ECG abnormalities were associated with high systolic blood pressures or with high cholesterol values was of interest. Table 8 shows the variation of the mean systolic blood pressures and mean serum cholesterol concentrations according to ECG classification in each study group. Among Filipinos in each age

**Table 6. Level of physical activity by ethnic group**

Physical activity at work	Japanese		Filipino	
	Number	Percent	Number	Percent
Light-----	75	44.1	131	28.5
Moderate-----	81	47.6	252	54.9
Heavy-----	14	8.2	76	16.6
Total-----	170	99.9	459	100.0

category, the mean systolic blood pressure was significantly higher when associated with ECG abnormalities than with normal ECG's. This relationship did not apply for either group of Japanese, although it could not adequately be tested with the small number of cases observed.

We noted a similar relationship in the association between serum cholesterol levels and abnormal ECG's. Only among Filipinos, especially those aged 50-64 years, did a clear association occur between high levels of serum cholesterol and abnormality of the ECG's.

A separate analysis for those groups showing specific signs of myocardial infarction, ischemia, or both, revealed no significant differences between Japanese and Filipino workers regarding the relationships of ECG classification to blood pressure and cholesterol levels.

## Discussion

Comparison of the distributions of risk factors between these Japanese and Filipino plantation workers suggested, under the assumption that the factors operate here as in other populations studied, that the Japanese were at greater risk of CHD than were the

**Table 5. Ponderal index by age and ethnic group**

Age group (years)	Japanese			Filipino		
	Number	Mean	S.D.	Number	Mean	S.D.
35-39-----	30	12.2	2.4	30	12.6	0.4
40-44-----	25	12.5	.6	57	12.6	.5
45-49-----	33	12.5	.5	38	12.4	2.1
50-54-----	37	12.7	.5	115	12.4	.5
55-59-----	24	12.7	.6	144	12.2	1.9
60-64-----	22	12.6	.5	79	12.5	.5

Filipinos. For given age groups, although blood pressure and ponderal index were similar, it was the Japanese who showed strikingly higher serum cholesterol levels, lower levels of occupational physical activity, and indeed for older persons higher frequency of ECG abnormalities consistent with the diagnosis of CHD. Further, when ECG abnormalities did occur among Filipinos, there was a demonstrable statistical association with exceptionally high levels of both serum cholesterol and systolic blood pressure. Only the uric acid levels, among the commonly recognized risk factors investigated in this study, showed that for most age groups the Filipinos were at relatively greater risk of CHD than the Japanese.

We sought confirmation of these results in reports from other studies among Japanese and Filipino residents of Hawaii, but strictly comparable data were lacking. The best comparison

available was the study of male employees of the city and county of Honolulu and the Hawaiian Telephone Company, reported by Stokes and co-workers (5). Their study population included 400 Japanese, more than half of whom were less than 45 years old, and only 27 Filipinos. Among Japanese 9.8 percent, and among Filipinos 7.4 percent, had reportable ECG abnormalities.

Although our data indicated much higher frequencies of ECG abnormalities for both ethnic groups, the discrepancy may be explained in part by differences in age and in criteria of ECG interpretation between the two studies. Even though a relative excess of ECG abnormalities existed among the Japanese studied in Honolulu, the number of Filipinos studied was too small to test adequately the differences observed. Similar to our results, data on blood pressure levels showed no clear

**Table 7. Electrocardiographic abnormalities by age and ethnic group**

Age and ethnic group	Number of persons	All abnormalities		Infarction, ischemia, or both <sup>1</sup>	
		Number	Percent	Number	Percent
Young Japanese.....	87	33	37.9	6	6.9
Young Filipinos.....	125	53	42.4	8	6.4
Old Japanese.....	83	41	49.4	13	<sup>2</sup> 15.7
Old Filipinos.....	336	142	42.3	22	<sup>2</sup> 6.5

<sup>1</sup> Blackburn's classes I, II, III, and VII, excluding nonspecific changes.

<sup>2</sup>  $P < 0.0005$ .

**Table 8. Systolic blood pressure and serum cholesterol levels by age, ethnic group, and electrocardiographic classification**

Ethnic group and ECG	Number	Systolic blood pressure		Serum cholesterol level	
		Mean (mm. Hg)	S.D.	Mean (mg. per 100 cc.)	S.D.
Young Japanese:					
Normal.....	54	132.2	16.91	251.1	47.55
Abnormal.....	33	139.0	21.30	251.5	59.19
Young Filipinos:					
Normal.....	72	<sup>1</sup> 127.3	16.45	217.6	43.57
Abnormal.....	53	<sup>1</sup> 136.6	17.90	223.8	54.02
Old Japanese:					
Normal.....	42	140.9	21.49	253.4	43.13
Abnormal.....	41	147.3	26.77	255.3	47.86
Old Filipinos:					
Normal.....	194	<sup>1</sup> 141.3	22.50	<sup>1</sup> 219.7	45.29
Abnormal.....	142	<sup>1</sup> 148.3	29.96	<sup>1</sup> 230.4	54.86

<sup>1</sup>  $P < 0.05$ .

differences between the Japanese and Filipino groups in the Honolulu study. No other data for Filipinos could be discovered.

Data on cholesterol levels among Japanese in Japan, Hawaii, and California were presented by Keys and co-workers (1). Interpreting their published figures for Japanese men aged 40-49 years, we noted that the study sample in Japan showed mean serum cholesterol levels of approximately 140-195 mg. per 100 cc. for various geographic and occupational subgroups. Japanese in Hawaii showed cholesterol levels of 220 mg. per 100 cc. and Nisei in Los Angeles, Calif., levels of 245 mg. per 100 cc. According to unpublished data of the Honolulu Heart Program, Kuakini Hospital, Honolulu, the mean serum cholesterol level for Japanese men aged 45-64 was 218 mg. per 100 cc. Our observations in Kauai, though showing markedly higher values than those for Honolulu, resulted from analyses performed in the laboratory that serves the Honolulu Heart Program.

The similarity between our results and the cholesterol levels noted among Japanese in California was unexpected. Since the early report by Gordon (6) of the striking upward geographic gradient for cardiovascular-renal mortality among Japanese in Japan, Hawaii, and the continental United States, much interest has been focused upon detailed study of these populations. The Japanese population of Kauai is small (2,296 men aged 35-64, according to the 1960 census), and the small number of deaths makes comparisons of mortality tenuous (unpublished data, Division of Research Planning and Statistics, Hawaii Department of Health). Further study could be of value to determine the possible contributions of dietary, sociocultural, and other factors to the observed distributions of cholesterol levels as well as those of other risk factors for CHD. It appears that differences in environment and in life style assumed to underlie differences in risk factors for CHD between the Japanese of Hawaii and California, may be different in character but be as great in effect among Japanese in different parts of Hawaii.

## Summary

An industrial health screening examination conducted among employees of a sugarcane plantation in Kauai, Hawaii, in 1964 afforded an opportunity to study risk factors for coronary heart disease (CHD) among 463 male Japanese and 171 male Filipino workers, aged 35-64. Although systolic blood pressure levels and the ponderal index were similar for the two ethnic groups, the Japanese showed strikingly higher levels of serum cholesterol concentration, lower levels of occupational physical activity, and for older persons a higher frequency of electrocardiographic abnormalities consistent with the diagnosis of CHD.

Only the uric acid levels, among the risk factors studied in this paper, showed the Filipinos to be at relatively greater risk of CHD than the Japanese, if these factors are assumed to operate in Kauai as observed elsewhere. Comparison with data from other studies of Japanese showed unexpected results among the Japanese workers of Kauai, especially for serum cholesterol values, which were closer to the high levels previously reported for Japanese from California than for those from Hawaii.

## REFERENCES

- (1) Keys, A., et al.: Lessons from serum cholesterol studies in Japan, Hawaii and Los Angeles. *Ann Intern Med* 48: 83-94, January 1958.
- (2) Epstein, F. H.: The epidemiology of coronary heart disease: a review. *J Chronic Dis* 18: 735-774 (1965).
- (3) Levine, J., and Zak, B.: Total cholesterol in serum. *Clin Chim Acta* 10: 381-384 (1964).
- (4) Blackburn, H., et al.: The electrocardiogram in population studies: a classification system. *Circulation* 21: 1160-1175, June 1960.
- (5) Stokes, J., III, et al.: Coronary disease and hypertension in Hawaii: racial distribution in 1,167 men. *Hawaii Med J* 25: 235-240 (1966).
- (6) Gordon, T.: Mortality experience among the Japanese in the United States, Hawaii, and Japan. *Public Health Rep* 72: 543-553, June 1957.

## Tearsheet Requests

Darwin R. Labarthe, M.D. School of Public Health, University of Texas, P.O. Box 20186, Astrodome Station, Houston, Tex. 77025