AMERICAN

Journal of Epidemiology

Formerly AMERICAN JOURNAL OF HYGIENE

VOL. 104 SEPTEMBER, 1976 NO. 3

Original Contributions

ACCULTURATION AND CORONARY HEART DISEASE IN JAPANESE-AMERICANS[1]

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Marmot, M. G. (School of Public Health, U. of California, Berkeley, CA 94720), and S. L. Syme. Acculturation and coronary heart disease in Japanese-Americans. *Am J Epidemiol* 104: 225–247, 1976.

Among men of Japanese ancestry, there is a gradient in the occurrence of coronary heart disease (CHD). It is lowest in Japan, intermediate in Hawaii, and highest in California. This gradient appears not to be completely explained by differences in dietary intake, serum cholesterol, blood pressure or smoking. To test the hypothesis that social and caltural differences may account for the CHD differences between Japan and the United States, 3809 Japanese-Americans in California were classified according to the degree to which they retained a traditional Japanese culture. The most traditional group of Japanese-Americans had a CHD prevalence as low as that observed in Japan. The group that was most acculturated to Western culture had a three- to five-fold excess in CHD prevalence. This difference in CHD rate between most and least acculturated groups could not be accounted for by differences in the major coronary risk factors.

acculturation; blood pressure; cholesterol; coronary heart disease; diet; migrants; smoking

INTRODUCTION

Japan has the lowest mortality from coronary heart disease (CHD) of any industrialized country, and the USA has one of the highest CHD rates (1). Gordon, on the basis of vital statistics data, has reported that Japanese-Americans experience a

Received for publication November 29, 1975, and in final form March 25, 1976.

Abbreviation: CHD, coronary heart disease.

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Adapted from the Ph.D. dissertation in Epidemiology by Dr. Marmot.

Supported by grants (N05P01 NB06818, NO HL14783) and contract (N01 HV 4290) from the National Institutes of Health, and a fellowship from the Bay Area Heart Research Committee of the American Heart Association. Computing assistance was obtained from the Health Sciences Computing Facility, U.C.L.A., sponsored by N.I.H. Special Resources Grant RR-3.

The authors gratefully acknowledge the creative leadership of Dr. Reuel A. Stallones, who was responsible for the initiation and a major part of the design of this study; they further thank Dr. Warren Winkelstein, Jr., for his help and advice through every phase of the study; Dr. Margaret M. Clark for her helpful comments on the acculturation analyses; and Dr. Judith B. Cohen for her important input into this research.

CHD mortality rate intermediate between the low rate in Japan and the high rate in the US (2, 3). An epidemiologic study, undertaken to investigate these dramatic differences in disease (4), has confirmed that for men of Japanese ancestry there is a gradient in both CHD mortality (5) and CHD prevalence (6). The rate is lowest in Japan, intermediate in Hawaii, and highest in California.

The reasons for this gradient, however, are unclear. Differences in saturated fat intake do not completely explain the higher serum lipid levels seen among the Japanese-Americans as compared with the Japanese in Japan (7). Further, the CHD gradient is not abolished by controlling for differences in serum cholesterol, blood pressure and smoking among these Japanese men (6). These results are summarized in figure 1. It would thus appear that the major coronary risk factors do not account for a large part of the increase in coronary disease rates experienced by Japanese living in the US.

This paper addresses the possibility that social and cultural factors might account for the increase in CHD among Japanese-Americans. Despite the superficial similarities, there are striking social and cultural differences between modern Japan and America. As many social scientists have observed, traditional Japanese culture is a major factor shaping the way of life in present-day Japan (8–13). In particular, in Japan great emphasis is placed on group cohesion and group achievement, and on social stability. This is in clear contrast to the typical American emphasis on social and geographic mobility and on individualized striving ambition that has been described as the type A or coronary-prone behavior pattern (14). Both type A behavior and social mobility have been shown to be related to the occurrence of CHD (14–20).

Following Matsumoto (21), it is suggested that these features of traditional Japanese culture, i.e., community strength, group cohesion and social stability, may be stress-reducing and may play a role in protecting the Japanese from CHD. If this is true then the higher rates of CHD observed in Japanese-Americans as compared with Japanese in the home country could, in part, be due to their relinquishing of Japanese culture.

The opportunity to test this hypothesis further is provided by the study of Japanese-Americans in California who are undergoing acculturation, or cultural change. (Acculturation is used here as a broad term to cover all the facets of cultural and social change. This paper will distinguish between "cultural assimilation," the degree to which an individual has given up such cultural forms as speaking Japanese and traditional Japanese practices, and "social assimilation," the degree to which the individual has left the ethnic group for work, for professional help from doctor, dentist or church, and for social relationships. This follows Gordon (22).) It would be predicted that those Japanese-Americans who are more acculturated to a Western way of life would have a higher prevalence of CHD than those Japanese-Americans whose culture is more traditionally Japanese. Other migrant studies have shown that age at migration and length of time in the new country affect the degree to which the CHD rates of the migrants resemble those of the new country (23, 24). Analogous to these observations, it would be predicted that, if cultural factors are important in CHD occurrence, then the greater the exposure to Japanese culture during upbringing, the lower the prevalence of CHD among the Japanese-Americans.

This paper examines the relationship of acculturation and other coronary risk factors to prevalence of coronary heart disease in the Japanese of California.

Methods

Development of the cohort. In 1967, a census was initiated to enumerate the

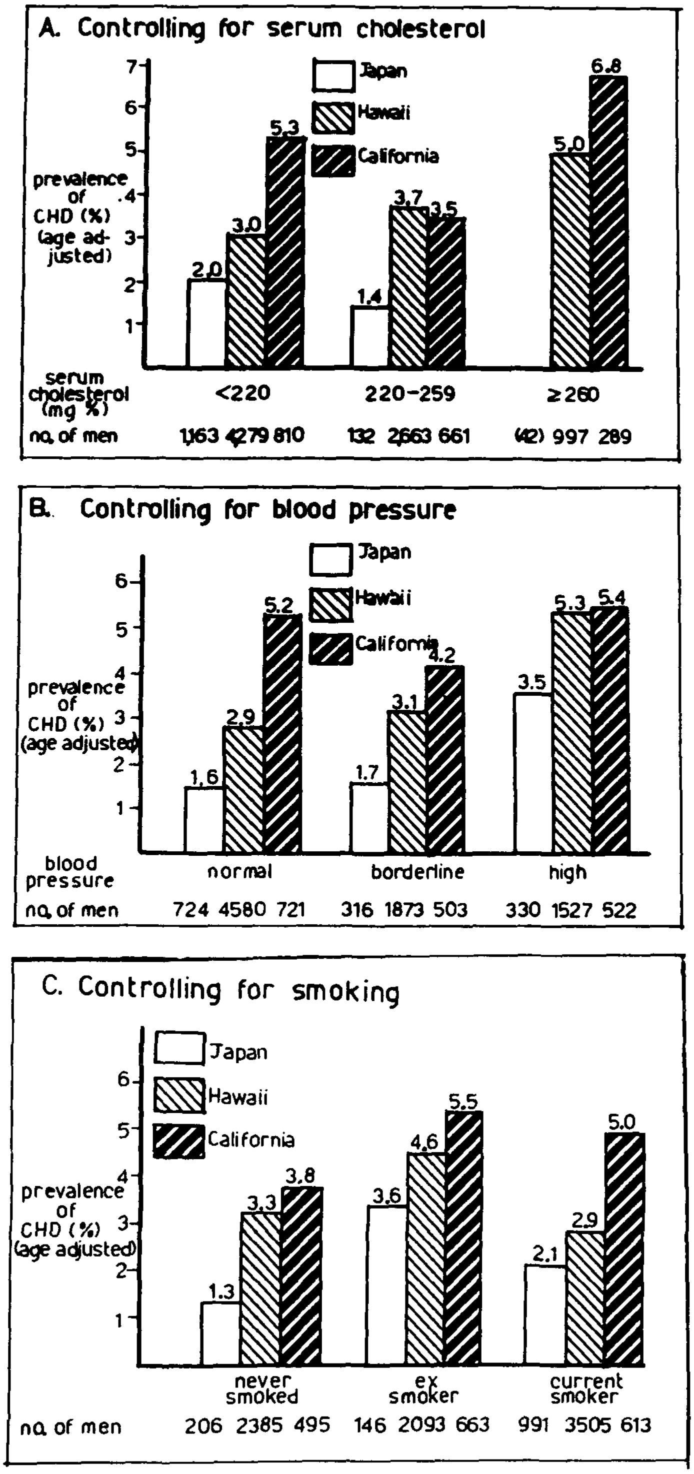

FIGURE 1. Prevalence of definite CHD in Japan, Hawaii and California. Definite CHD = Minnesota codes 1:1, 1:2, 7:1 or angina pectoris from cardiovascular questionnaire. In section B, normal, borderline and high blood pressure levels are defined according to World Health Organization criteria.

Japanese-Americans living in eight San Francisco Bay Area counties. Rosters of Japanese-Americans were obtained from Japanese organizations, Japanese newspapers and telephone directories. Questionnaires were sent to households containing Japanese-Americans and an up-to-date listing of Japanese in the Bay Area was thereby obtained. The completeness of this census was assessed by a door-to-door survey in selected census tracts and underenumeration was found to be less than 4 per cent. The details of this procedure have been reported elsewhere (25).

At the time that examination of the cohort was begun in November 1969, there were 4480 men aged 30–74. These were invited to attend the Kaiser-Permanente clinics in San Francisco and Oakland, and 2974 men were examined for a response rate of 66 per cent. An additional 835 men from Santa Clara County were examined.

Non-response. Questionnaires were mailed to all non-respondents, i.e., those individuals who were enumerated but did not attend the multiphasic examination at Kaiser. These questionnaires contained items from each of the medical, social and cultural questionnaires. Responses were received from 59 per cent of the "non-respondents."

Examination methods. Each study subject, at the time of examination, completed a set of self-administered questionnaires. These contained details of past medical history, smoking history, physical activity and dietary habits. Angina pectoris and possible myocardial infarction were assessed using the London School of Hygiene Cardiovascular Questionnaire (26, 27).

Blood pressure was measured by a nurse with the subject seated, after a period of accommodation to the setting. Repeated measurements were taken and these have been the subject of a separate report (28). The measurement used for the current analyses was the first recording in the left arm. Systolic and phase V diastolic (disappearance of sound) blood pressures were recorded.

Relative weight. Weight in pounds and height in inches were measured in standard fashion and a relative weight for each individual was computed as: Relative weight = actual weight/ideal weight × 100. The ideal weight is based on measurements made on the cohort of Japanese-Americans examined in Honolulu. It is the mean weight for each height for men whose arm and back skinfold thickness summed to 10–12 mm. This, in fact, represents quite a "thin" ideal weight and is in no sense an average weight.

Electrocardiogram. Conventional 12-lead electrocardiograms were taken and copies of the tracings sent blind to Dr. Blackburn's laboratory for coding according to the Minnesota code (29).

Biochemistry. Subjects were non-fasting and received a 50 gm glucose load. The glucose load was given after the electrocardiogram was taken. Blood specimens were taken one hour later and analyzed in the laboratory of the US Public Health Service Hospital, San Francisco. This laboratory was a participant in the lipid standardization program of the US Public Health Service. The methods used to measure serum cholesterol, triglyceride and glucose, and the details of the quality control procedures are described elsewhere (30).

Acculturation. Each subject completed a questionnaire that pertained to social and cultural background, to current behaviors and to current attitudes. This included the Ethnic Identity Scale, which was based on a questionnaire developed in a study of Japanese-Americans in Seattle, Washington (31, 32), and used in Honolulu, Hawaii (33). From the questionnaire, indices of acculturation were derived that reflected the degree to which the individual could be described culturally and socially as "traditional" Japanese or "westernized." The rationale for the indices chosen and the method by which they were derived are described in greater detail elsewhere (34) and are only outlined briefly here.

The three acculturation indices to be reported on here are 1) culture of upbringing, 2) cultural assimilation, 3) social assimilation. The indices were developed by grouping together the answers to questions that reflected an underlying dimension of acculturation. A formal cluster analysis was performed on the acculturation data using the method of Tryon (35). If the variables (questions) in the above groupings were correlated highly with each other, then the "conceptual" groupings were retained. An index score was then simply obtained by summing the standardized scores on the individual questions in the grouping. This was the procedure used to develop scores for "culture of upbringing" and "cultural assimilation." The questions grouped under social assimilation did not cluster together in the Tryon cluster analysis. These questions will therefore be used separately as indicators of social assimilation.

Diet. To measure dietary intake, a measure of dietary preference devised by Dr. R. A. Stallones was used. Individuals were asked to indicate which of a number of food items they ate in the previous 24 hours. Eight of these food items were traditional Japanese items and nine typically Western items and the dietary preference score was expressed as the no. of Japanese items consumed/total no. of items consumed in 24 hours. Thus, a high score represents a Japanese food preference and a low score a Western food preference. This score was validated for a subsample of 320 individuals by a 24-hour dietary recall interview administered by a nutritionist. Figure 2 plots the per cent calories from fat in the diet for groups of individuals, grouped by decile on the dietary preference scale. There is a fairly consistent relationship ranging from 43 per cent calories from fat for subjects with the most Western dietary preference score to 33 per cent calories from fat for the group with the most Japanese dietary preference score. If the scale of dietary preference scores is divided into a Western half and a Japanese half, the mean per cent calories from fat in two halves are 40 per cent and 34.9 per cent, respectively.

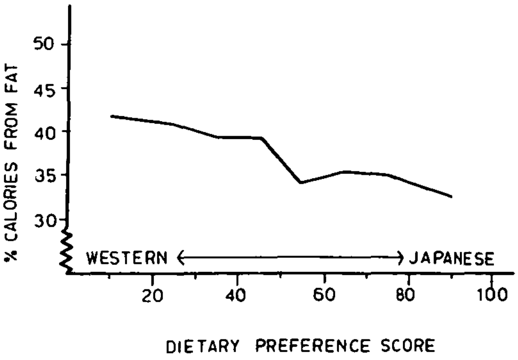

FIGURE 2. Dietary preference and per cent calories from fat.

RESULTS

Table 1 presents the distribution of the study population by age and generation (Issei, Nisei). It may be seen that only 14.6 per cent of the cohort were Issei (born in Japan). The results that follow will therefore not be presented separately by generation. It should be borne in mind, however, that as there is very little overlap in age between Issei and Nisei, differences between older and younger men may be due to age or to generational differences.

Comparisons between the data from the examined population and the mail questionnaires returned by the non-respondents, revealed that the non-respondents reported equal frequencies of chest pain and diagnosed heart disease to the examined group, but a greater frequency of diagnosed stroke. There were small differences in the answers to the social and cultural questions that indicated the non-respondents to be slightly less acculturated. These results are reported more fully in the doctoral thesis by Marmot (34).

Culture of upbringing and CHD. Culture of upbringing combines information on the

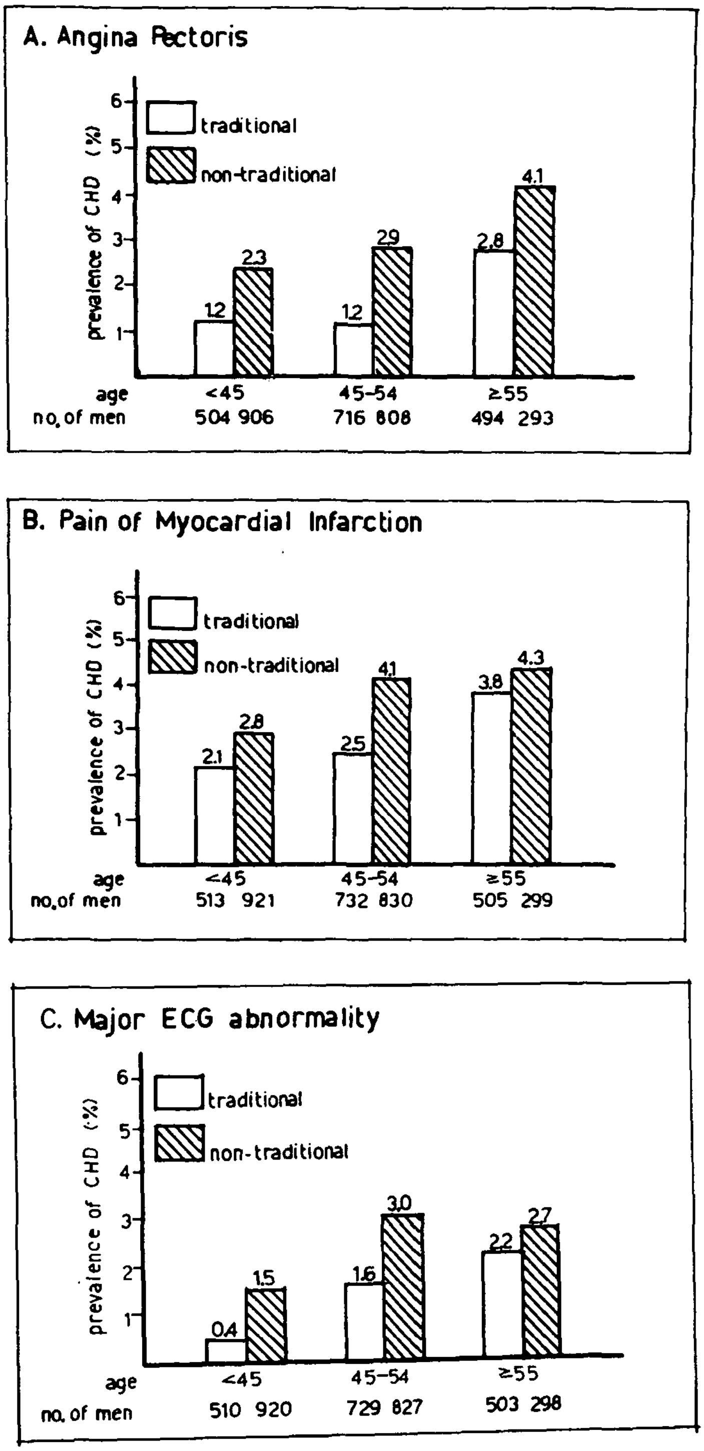

FIGURE 3. Prevalence of different manifestations of CHD by culture of upbringing. Data from cardiovascular questionnaire (on angina pectoris, pain of myocardial infarction) and major ECG abnormality (Minnesota codes 1:1, 1:2, 7:1).

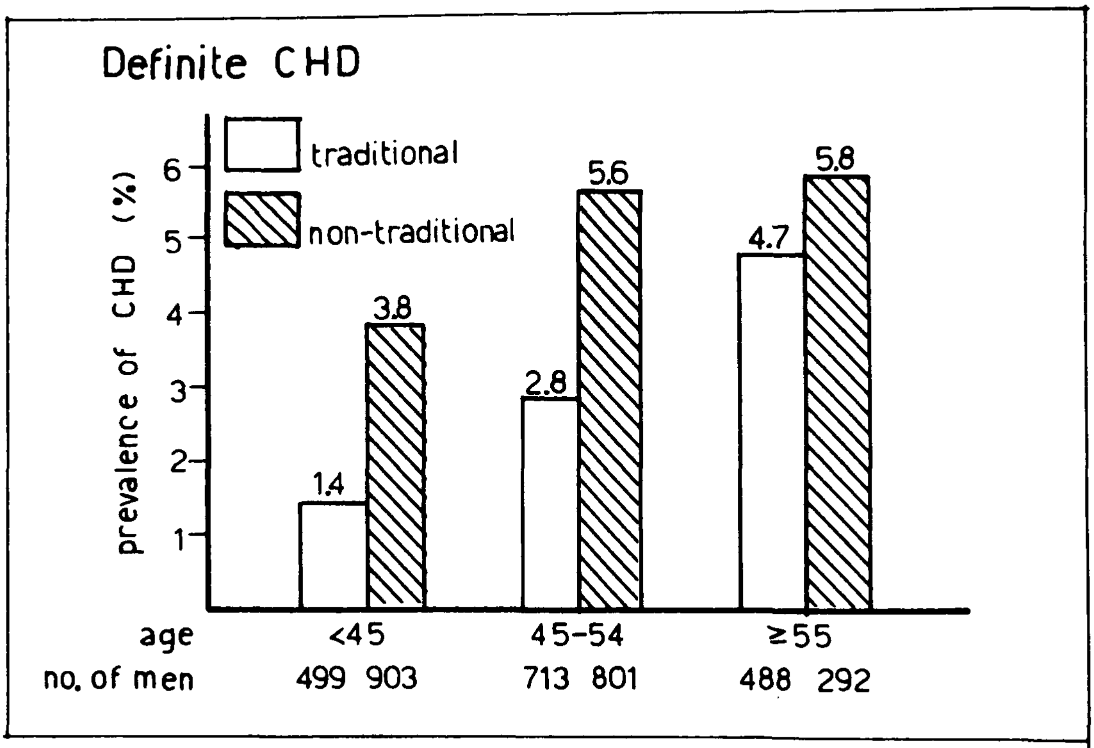

FIGURE 4. Prevalence of CHD by culture of upbringing.

of figures 3 and 4 reveals that age is also associated with degree of acculturation. The more traditional men have an older age distribution than the non-traditional men. Hence the importance of controlling for age in these analyses. The possibility was examined that within each of these broad age groupings the traditional men were older than the non-traditional, but this proved not to be the case.

Smoking. Figure 5 presents the relationship of culture of upbringing to definite CHD, controlling for smoking. The higher prevalence of CHD in the acculturated group persists, the relative prevalence being as high as 3 in the current smoking category. It might be suggested that "current smoking" is a very crude way of controlling for smoking, given that risk of CHD has been shown to increase with the number of cigarettes smoked. The proportions of current smokers who smoked different numbers of cigarettes/day were therefore compared for each of the two acculturation groups.

Culture of upbringing	Per cent of smokers who smoke:		
	1–14 (cigs/day)	15–24 (cigs/day)	≥25 (cigs/day)
Traditional	20.7%	50.5%	28.8%
Non-traditional	20.0%	50.6%	29.4%

Given that the distribution of smokers among the smoking categories is identical in the two acculturation groups, it seems unlikely that this acculturation-CHD association is due to smoking.

Diet. It is clear that culture of upbringing shows an association with prevalence of CHD, whichever definition of CHD is used. However, those whose upbringing is more traditionally Japanese also eat diets that are more Japanese, i.e., lower in fat content, among other things (34). It is important to assess the association of culture of upbringing to CHD, independent of dietary

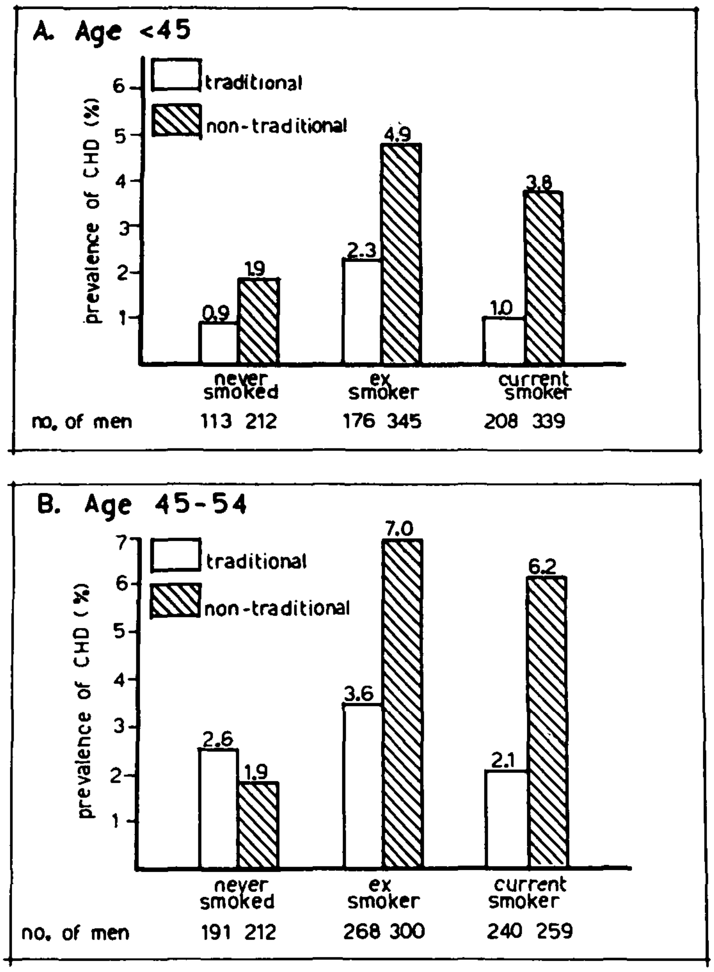

FIGURE 5. Prevalence of definite CHD by culture of upbringing controlling for smoking.

pattern. In figure 6, the population is divided on the basis of dietary preference, scored as Japanese or Western, and within those groups further divided into traditional and non-traditional on the basis of culture of upbringing. The higher prevalence of definite CHD in the non-traditional group persists within both dietary groups and at both ages. The relative prevalence continues to be in excess of 2, between more and less acculturated groups.

One surprising finding from this figure is that dietary preference is negatively related to CHD. The possibility was explored that those with a more Japanese diet were consuming more salt and hence had higher blood pressures than those on a Western diet, but this proved not to be the case. There was also only a very small association between serum cholesterol and dietary preference, thus differences in this factor could not account for the higher CHD rate in the group consuming a more Japanese diet. However, among those with a more Japanese diet there was a slightly higher proportion of smokers. The relationship of dietary preference to definite CHD is therefore examined, controlling for smoking (table 2). The prevalence of CHD is higher among smokers than non-smokers, but it is actually highest in the ex-smoker category. It may be seen that the negative

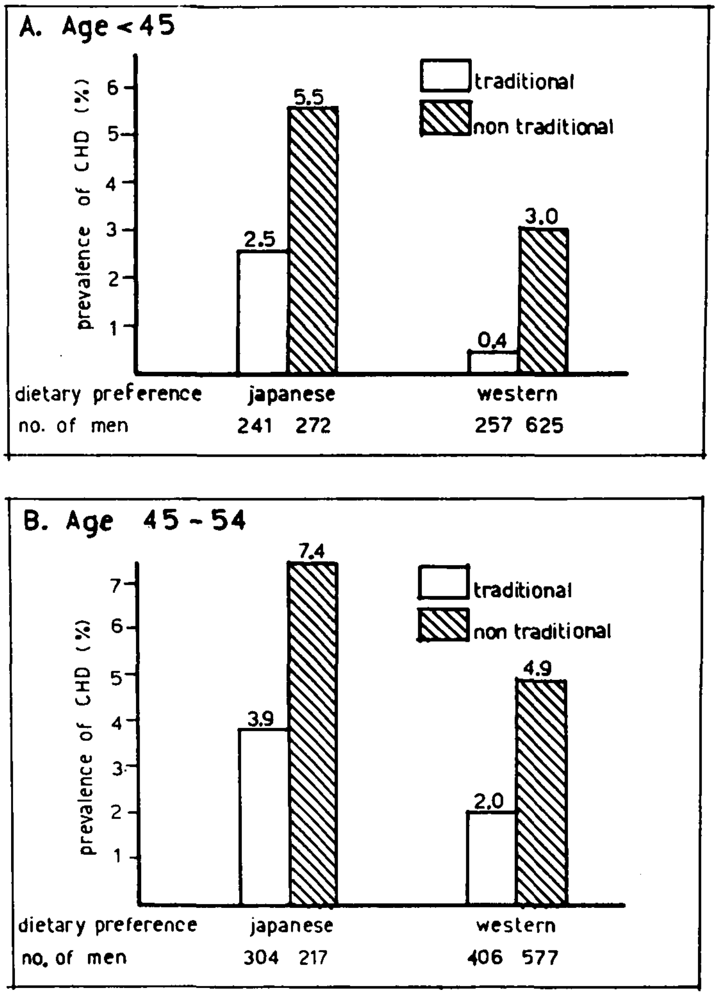

FIGURE 6. Prevalence of definite CHD by culture of upbringing controlling for dietary preference.

association between dietary preference and CHD is most marked in the ex-smoking category. It is possible, albeit a little far-fetched, that this unexpected finding is the result of the bias of a retrospective study, i.e., that individuals who developed CHD changed their diet to a more prudent (Japanese) diet and gave up smoking. (Alternatively, it is possible that individuals with a more Japanese diet were more likely to give up smoking after developing CHD.) Either explanation would then account for the clustering of cases in the ex-smoker-Japanese diet subgroup. No data are available to support or refute this speculation, so this finding remains unexplained.

Serum cholesterol. Figure 7 presents the same relationship of culture of upbringing to definite CHD controlling for serum cholesterol level. The cholesterol distribution is divided into three groups, <220, 220–259, and ≥260. Although the numbers in many of the categories are quite small, there is a remarkable consistency of the acculturation-CHD relationship that appears not to be removed by controlling for serum cholesterol level.

Analogous to the smoking issue, the possibility was explored that differences in

TABLE 2
Prevalence of definite CHD by dietary preference and smoking

Smoking, by age	Dietary preference			
	Japanese		Western	
	No. of men	% CHD	No. of men	% CHD
Never smoked				
<45	113	0.9	213	1.9
45–54	134	3.7	295	3.1
Ex-smoker				
<45	184	6.5	337	2.7
45–54	203	8.4	372	3.8
Current smoker				
<45	214	3.7	331	2.1
45–54	182	3.8	313	4.2

the distributions of serum cholesterol between the two acculturation groups are not properly controlled for, by using these broad cholesterol groupings. The means of cholesterol within each of the cholesterol subgroups (<220, 220–259, ≥260) were compared for the traditional and non-traditional groups and found to be within 2 mg/100 ml for each cholesterol subgroup. It is thus reasonable to conclude that differences in serum cholesterol do not account for the acculturation-CHD association.

Blood pressure. The relationship of culture of upbringing to definite CHD is presented in figure 8, controlling for blood pressure level. For this analysis WHO criteria of hypertension are used. They are as follows:

high blood pressure—systolic ≥160 mm Hg *or* diastolic ≥95 mm Hg;

normal blood pressure—systolic <140 mm Hg *and* diastolic <90 mm Hg;

borderline blood pressure—the residual category, i.e., systolic <160 *and* diastolic <95, but not both simultaneously <140 and <90, respectively.

At each blood pressure level the higher CHD prevalence in the non-traditional group persists. As the confidence intervals about the rates must necessarily be reasonably large when the population is divided by age, acculturation and blood pressure, it is not really possible to make precise statements about the trend in the magnitude of the relative prevalence over the different blood pressure groups. However, the direction of association between acculturation and CHD is quite consistent. The failure to see a consistent rise in CHD rates with rise in blood pressure may have been due to the fact that these are prevalence cases and blood pressure may have changed after the disease developed.

Once again, the procedure of controlling for a variable by stratifying into these broad categories was "checked" by comparing means of systolic and diastolic blood pressure between acculturation groups at each level of blood pressure. Once again, the difference in means between traditional and non-traditional groups was not greater than 2 mm Hg for any of the blood pressure categories. These blood pressure groupings did, therefore, control adequately for blood pressure differences.

To control simultaneously for age, serum cholesterol and blood pressure in examining this acculturation-CHD association, the Mantel-Haenszel procedure (37) was used. The relative risk between acculturated and non-acculturated groups, adjusted for differences in these three factors, is 1.83.

Serum triglyceride. Serum triglyceride, relative weight and serum glucose all have the status of "minor risk factors" in conventional usage. Nevertheless, it is important to control for these, as each has been shown to be associated with CHD occurrence.

In figure 9, arbitrary cut points of 145 and 250 mg/100 ml are chosen to divide the triglyceride distribution into approximately three equal groups. The acculturation-CHD relationship is again seen in five of the six triglyceride-age subgroups. It will be noted that the prevalence of CHD is lowest in the low triglyceride group, but

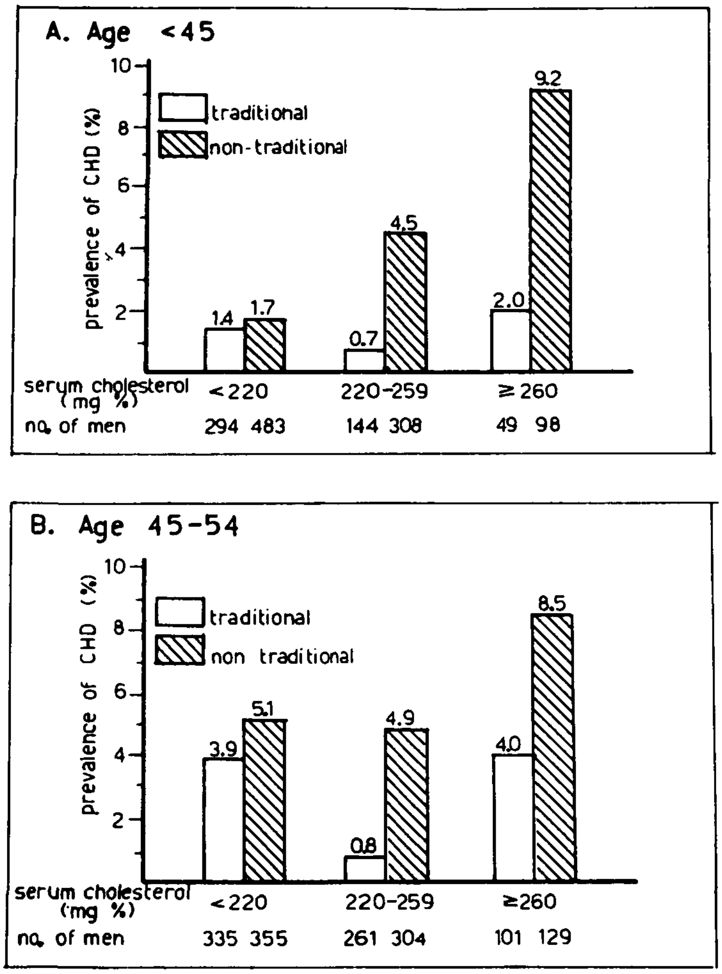

FIGURE 7. Prevalence of definite CHD by culture of upbringing controlling for serum cholesterol.

the relationship of serum triglyceride to CHD appears to level off in the highest triglyceride group.

Relative weight. Figure 10 presents the relationship of acculturation (culture of upbringing) to definite CHD, taking account of relative weight. As the "standard" population of Hawaii Japanese was quite thin, almost no one in this population had the "ideal" weight of 100 and the mean relative weight was in excess of 120. Hence, the cut points were chosen to reflect "below average" relative weight, "above average," and "high." Allowing for the small numbers problem, this figure shows that relative weight is associated with CHD in this population, but that the acculturation-CHD association exists independent of any differences in relative weight.

Serum glucose. As post-load serum glucose levels of 170 and 200 mg/100 ml have been considered by others to be "high," these were chosen as cut points. As figure 11 shows, one problem with this choice is the small numbers in some of the cells. The small numbers problem, for example, may account for the low prevalence of CHD seen in the ≥200 category of the younger, non-traditional group. However, in all of the other age-glucose categories, the non-traditional group had a higher prevalence of CHD.

Thus, these results support the hypothesis that the culture in which an individual is raised affects his likelihood of manifesting coronary heart disease in adult life. This relationship of culture of upbringing to CHD appears to be independent of the established coronary risk factors.

Cultural assimilation and coronary heart disease. Cultural assimilation combines information on: ability to read Japanese; frequency of speaking Japanese to wife; frequency of speaking Japanese to children; frequency of speaking Japanese to friends. It is an index of the degree to which an individual has relinquished Japanese cultural forms.

Figure 12 presents the relationship between cultural assimilation and prevalence of definite CHD. The acculturation-CHD relationship is not as strong as was seen with culture of upbringing, but it is in the same direction with slightly higher rates in the non-traditional group.

As was done in the previous section, the results were examined separately for angina, pain of possible myocardial infarction, and ischemic ECG abnormality and the results were similar, i.e., this modest acculturation-coronary heart disease association held for each of the subcategories of coronary heart disease.

As was done with culture of upbringing,

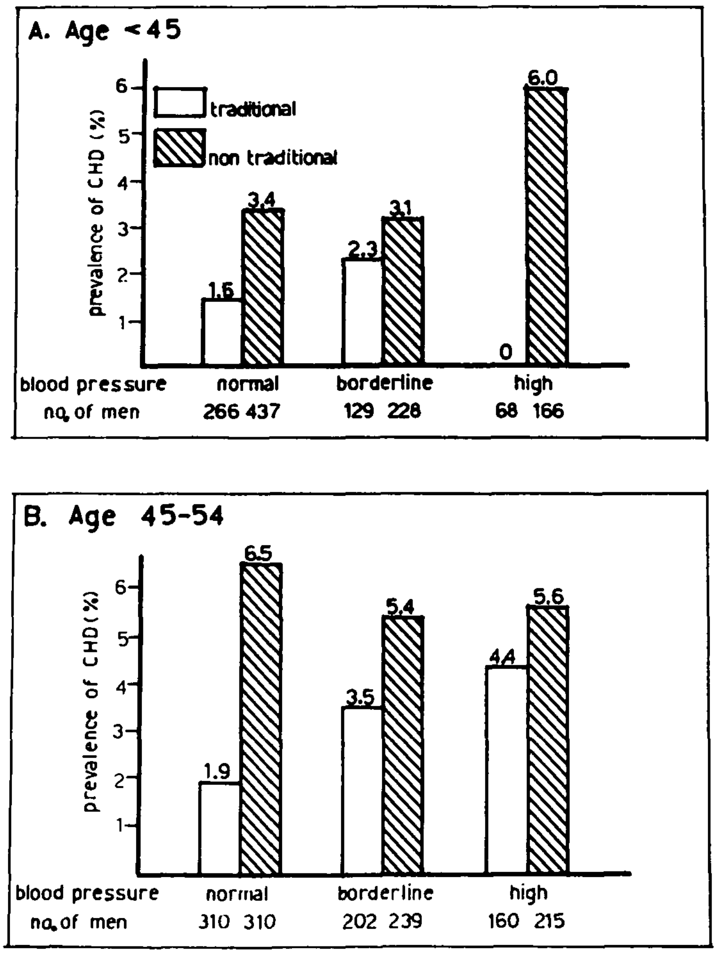

FIGURE 8. Prevalence of definite CHD by culture of upbringing controlling for blood pressure level. Normal, borderline and high blood pressure levels are defined according to WHO criteria.

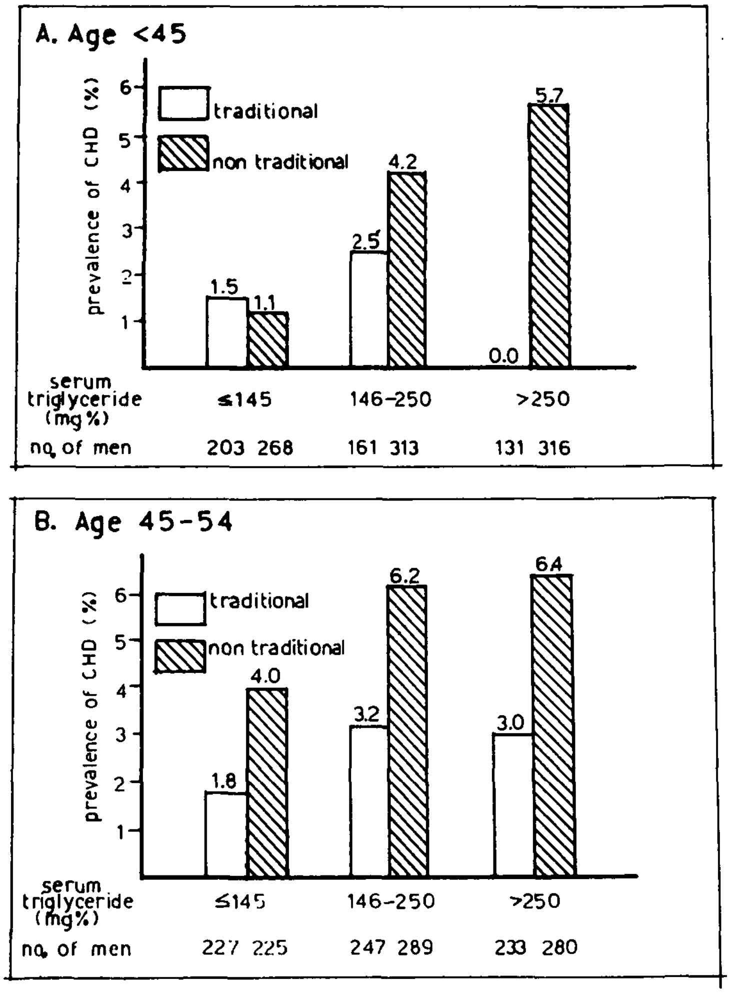

FIGURE 9. Prevalence of definite CHD by culture of upbringing controlling for serum triglyceride.

the cultural assimilation-definite CHD association was then examined, controlling successively for dietary preference, smoking habits, blood pressure level, serum cholesterol, serum triglyceride, relative weight and serum glucose. The relationship was neither as strong nor as consistent as was seen with culture of upbringing, but in general, the non-traditional group had a slightly higher prevalence of CHD than the traditional group (34).

Culture of upbringing, social assimilation and CHD. From the foregoing, it would appear that individuals who were exposed to traditional Japanese culture during their upbringing have a lower prevalence of CHD in middle age than individuals who were more acculturated. The question at issue is to identify what features of a traditional Japanese life style may be responsible for this apparent protection from CHD; and, in particular, to test the hypothesis that those Japanese-Americans who retain the traditional commitment to the community group would be at lower risk from CHD. This can be tested by examining the relationship of social assimilation to CHD, as social assimilation is equivalent to leaving the ethnic group.

The following variables representing social assimilation were examined singly in relation to the prevalence of definite CHD:

ethnicity of dentist or doctor (for convenience labeled ethnicity of professional), ethnicity of friends now, ethnicity of coworkers, ethnicity of employer, frequency of socializing with coworkers, and importance of religion. No consistent pattern was seen.

However, because culture of upbringing was so strongly associated with CHD, and is correlated with these social assimilation variables to a variable extent, culture of upbringing should be taken into account in the analysis. Thus, the focus of the question becomes: does the addition of these social assimilation variables to the culture of upbringing-CHD relationship improve the ability to distinguish high-CHD groups from low-CHD groups on sociocultural grounds? To answer this question, the population can be subdivided into four groups as follows:

Culture of upbringing	Social assimilation*	
	Traditional	Non-traditional
Traditional	*a*	*b*
Non-traditional	*c*	*d*

* *a* may be labeled traditional, *d* non-traditional, *b* and *c* are intermediate.

Table 3 presents the prevalence of definite CHD, with the population stratified by ethnicity of professional (Japanese den-

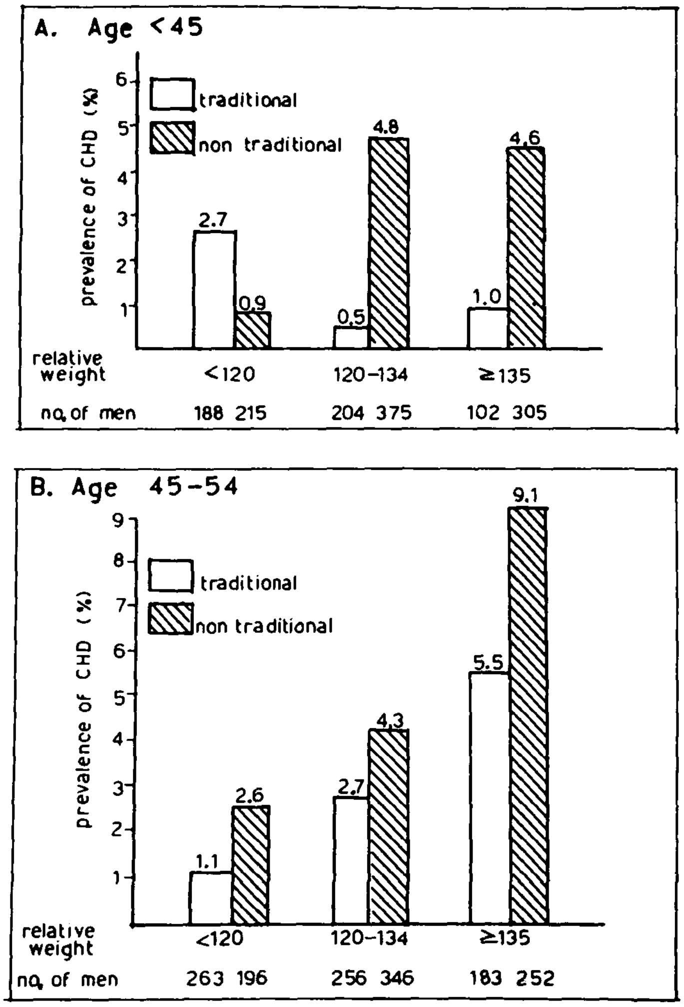

FIGURE 10. Prevalence of definite CHD by culture of upbringing controlling for relative weight.

tist or doctor) and culture of upbringing. It can be seen from this table that in both ages <45 and 45–54 the two intermediate groups corresponding to "*b*" and "*c*" of the previous fourfold grouping have very similar rates, and these rates are intermediate between the low rates in the traditional group ("*a*" in the fourfold grouping) and the high rates in the non-traditional group ("*d*" in the fourfold grouping). It therefore seems reasonable to pool the two intermediate groups, thus forming three groups: traditional, intermediate, and non-traditional. This is done in figure 13A which presents the prevalence of definite CHD in each of the three groups formed on the basis of ethnicity of professional and culture of upbringing. There is a steadily increasing relationship of acculturation to CHD. The relative prevalence between most and least acculturated groups is 5.1 in the younger group and 2.5 in the 45–54 age group. This is an improvement over the relative prevalence of 2.7 and 2.0 seen in the corresponding age groups with culture of upbringing alone. In addition, adding the social assimilation variable has allowed the "risk" to be spread out among three different groups, depending on the degree of acculturation.

Figure 13B presents the same data, this time with social assimilation defined by

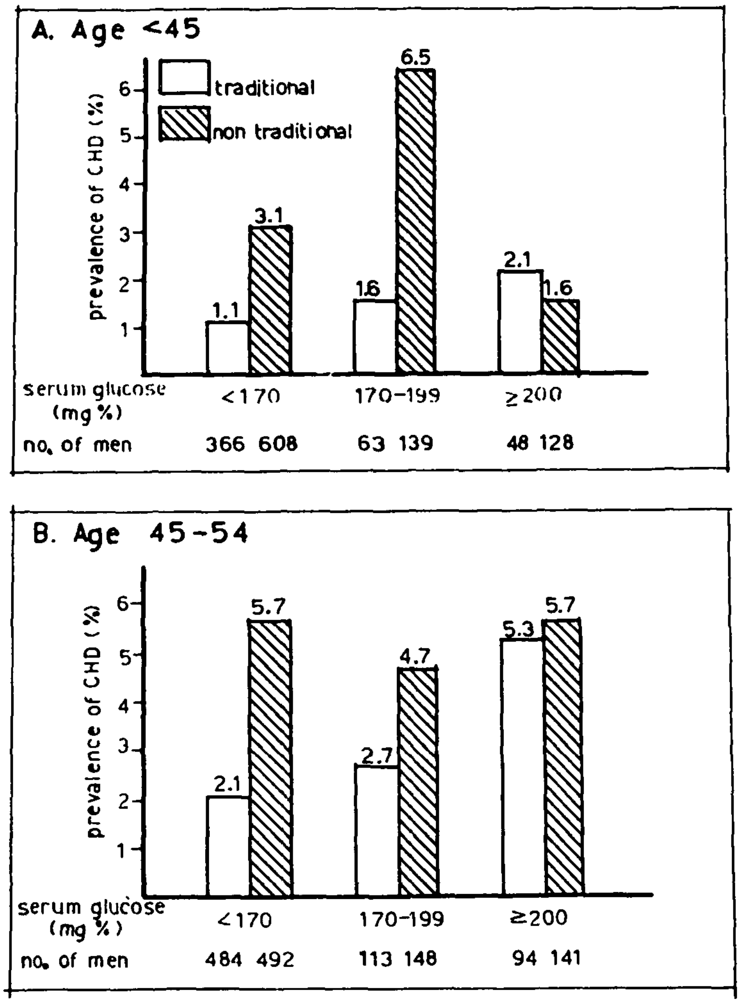

FIGURE 11. Prevalence of definite CHD by culture of upbringing controlling for serum glucose.

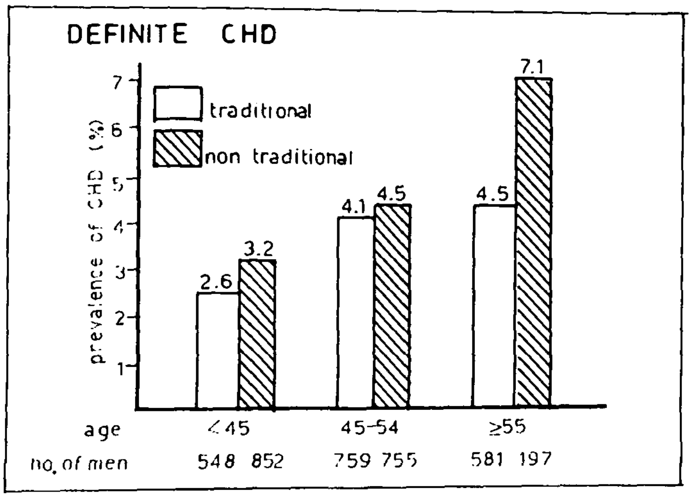

FIGURE 12. Prevalence of CHD by cultural assimilation.

ethnicity of coworkers. Again, the consistent relationship is seen; this time the relative prevalence is higher (4.0) in the 45–54 age group.

In comparing figure 13A with 13B, it is interesting to note that the numbers of men that fall in each acculturation category in figure 13A are quite different from the numbers that fall in each category in figure 13B. This is true both of numerators (the number of CHD cases) and denominators, e.g., comparing figure 13A with figure 13B, the numbers of cases/total number in each of the acculturation groups for age 45–54 are as follows:

	Traditional	Intermediate	Non-traditional
Figure 13 A (ethnicity of professional)	17/596	28/619	21/289
Figure 13B (ethnicity of coworkers)	4/291	21/467	42/755

This suggests that this relationship of acculturation to CHD is not an artefactual occurrence that is being reproduced time and again by simply giving the same men different labels. In other words, the fact that these measures of social assimilation are only partly correlated with each other is an indication that relatively independent measures of acculturation have each shown a relationship to CHD occurrence.

Of the other measures of social assimilation that were analyzed in this way, the findings for "ethnicity of employer," "frequency of socializing with coworkers," and "importance of religion" yielded a similarly consistent relationship between degree of acculturation and prevalence of definite CHD. Only "ethnicity of friends now" showed no clear relationship to CHD.

This CHD-social assimilation-culture of upbringing association was examined separately for angina pectoris and ischemic ECG abnormality. The same relationship holds for each of these separate manifestations of CHD.

As was done with culture of upbringing and CHD, this CHD-acculturation association was examined controlling successively for each of dietary preference, smoking,

TABLE 3

Prevalence of definite CHD by culture of upbringing and social assimilation (ethnicity of professional)

Culture of upbringing	Ethnicity of professional			
	Traditional		Non-traditional	
	No. of men	% CHD	No. of men	% CHD
Age <45				
Traditional	409	1.0	77	2.6
Non-traditional	555	3.1	336	5.1
Age 45-54				
Traditional	596	2.9	113	3.5
Non-traditional	506	4.7	289	7.3

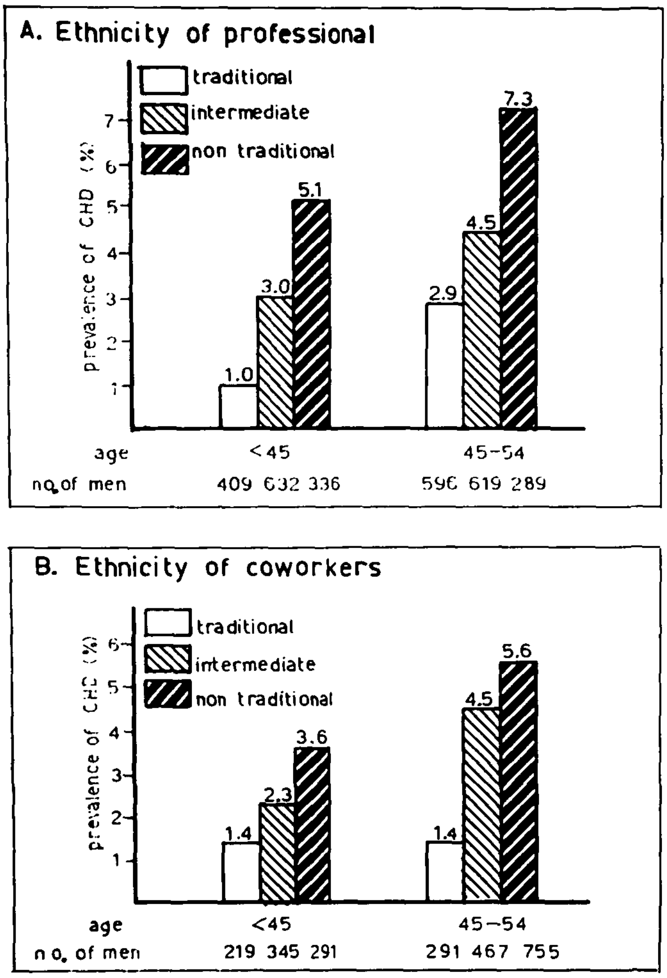

FIGURE 13. Prevalence of definite CHD by culture of upbringing and social assimilation.

serum cholesterol and blood pressure. The same consistent acculturation-CHD relationship was seen to persist (34).

In sum, this section lends support to the hypothesis that retention of Japanese group relationships is associated with a lower rate of CHD. Five out of the six measures of social assimilation showed an association with prevalence of CHD over and above that seen with culture of upbringing alone.

The index of cultural assimilation was then combined with the index of culture of upbringing in the same fashion as above, i.e., to form traditional, intermediate and non-traditional groups. However this combination showed no clear relationship to CHD prevalence over and above that seen with culture of upbringing alone. It would therefore seem that the acculturation-CHD relationship is specific to culture of upbringing and social assimilation and does not include cultural assimilation.

DISCUSSION

Prevalence problems

Before discussing the implications of these findings, a note of caution should be sounded. This was a cross-sectional study with a sizeable non-response rate. It is possible therefore that the observed relationship between acculturation and CHD is solely due to bias. However, for this to be the case, it would be necessary for the traditional individuals among the non-respondents to have had a very much higher CHD rate than the acculturated individuals. There is no evidence that this was so. The survey of the non-respondents suggested that, for the 59 per cent that could be reached, the rate of chest pain and diagnosed CHD was no higher than for the examined population. In addition, a surveillance of mortality has been carried out for both the examined and the total non-response group. In the first 24 months of follow-up, the age-adjusted mortality rates for the examined group was 18.8/1000 and for the non-examined group was 20.7/1000. It therefore seems unlikely that non-response bias alone could account for the acculturation-CHD relationship.

As well as the issue of non-response, as these are prevalence data, it is possible that different CHD case-fatality rates in the two groups, traditional and non-traditional, could account for some of the differences in CHD prevalence. This can only be settled by a follow-up study.

The other possible problem with a cross-sectional study is that characteristics of individuals with CHD may have changed subsequent to development of the disease. It was pointed out in the Results section that the finding of a higher CHD prevalence in the ex-smoker group, and in particular, in the group of ex-smokers with a Japanese dietary preference, may have been on this basis, i.e., individuals may have stopped smoking and changed their diet after developing the disease. However, it seems unlikely that the association between CHD prevalence and social assimilation could have been the result of individuals becoming assimilated after developing the disease. It is, of course, highly improbable that culture of upbringing could have changed subsequent to the disease, and there is no reason to suspect a reporting bias in this area.

The conclusion to these deliberations should perhaps be that it does not seem overwhelmingly likely that the observed acculturation-CHD relationship was the result of the methodological problems discussed. However, this was a prevalence study with a sizeable non-response; the conclusions should therefore be accepted with caution.

Diet

Because of the obvious a priori possibility that acculturation is merely a reflection of westernization of dietary pattern, it is important to summarize the evidence relating diet to CHD in this study.

The major epidemiologic evidence relating dietary intake to CHD occurrence has come from indirect studies, i.e., population figures for average fat consumption have been correlated with population means of serum cholesterol and population rates of CHD (38). One of the arguments to explain the failure to observe a direct relationship between dietary intake and CHD occurrence has been that, within populations, the range of dietary intake was too small (39).

In the collaborative study in Japan, Hawaii and California, the mean per cent calories from fat in the diet ranged from 15 per cent in Japan to 37.6 per cent in the California Japanese. This is consistent with an important role for diet in the determination of serum cholesterol, yet when Japanese men eating equivalent diets were compared in the three places, the Japanese-Americans still had higher serum cholesterols than the Japanese in Japan (7). It would appear, therefore, that some part of the differences in serum cholesterol is due to factors other than fat intake.

Within the California Japanese population, the per cent calories from fat in the diet ranged from 33 per cent to 43 per cent, yet only a very minor association was seen with serum cholesterol (34) and a negative association was seen between dietary pattern and CHD. It might be argued that this was not a good test of the dietary hypothesis as the California Japanese with a "Japanese" dietary preference clearly had very Westernized diets, higher in fat intake, than the Japanese in Japan. Two comments are relevant to this argument. Although the dietary range in California may have been comparatively narrow, there was a fivefold difference in CHD prevalence between most acculturated and least acculturated groups, i.e., there was a sufficient range in heart disease prevalence in the study population. The least acculturated group had a prevalence rate similar to the low rate seen in Japan. If this range of CHD prevalence exists within the California cohort despite the "narrow" range of dietary intake, it supports the notion that the differences in CHD between Japan and California may be due to cultural differences rather than exclusively due to dietary differences.

Also relevant to the question of the range of fat intake necessary to account for CHD differences, are the findings of the Seven Countries Study (38). The populations of Greece and Yugoslavia averaged 32–33 per cent calories from fat as compared with 40 per cent calories from fat in the US cohort, a range comparable to that in the California Japanese. It was concluded that these differences in fat intake played a major role in causing three- to five-fold differences in CHD incidence. Had dietary differences played a major role in determining the differences in CHD in this study of Japanese men in California, the range of dietary intake should have been sufficient to detect it. In the Seven Countries Study, the correlation with CHD was stronger for saturated fat intake than for total fat intake, but in this Japanese study, saturated fat intake was highly correlated with total fat intake so the distinction would not make a great difference to the present argument.

It could, of course, be objected that the failure to show a diet-CHD relationship within California might have been due to the unreliability of the dietary methods used. While the measure of dietary preference used here might be considered a little vague, it correlated well with other measures of nutrient intake between cohorts (24-hour recall and seven-day diary) and within the California cohort (24-hour recall) (40). Thus, despite its apparent imprecision, the dietary preference score appears to give a reasonable reflection of patterns of nutrient intake, for groups of people if not for individuals.

Lastly, it should be pointed out that all the dietary measures, and all the relevant evidence adduced here, relate to current dietary patterns. It is possible, and likely, that those whose upbringing was more traditionally Japanese had diets in early life that were more Japanese, i.e., low in saturated fat. It is possible, therefore, that the observed relationship between culture of upbringing and CHD is due to early dietary patterns and not to cultural factors. Pursuing this counter-hypothesis, one would argue that although the acculturation-CHD relationship was not abolished by controlling for serum cholesterol, this could not be construed as evidence against the importance of early diet. One would take note of the lack of any difference in serum cholesterol levels between the traditional and non-traditional groups in this study (34), and one would argue that the group with traditional upbringing had Westernized their diet and achieved a rise in serum cholesterol comparatively late in life. Thus, one would conclude, marked differences in early diet could be a reason for the higher CHD rate in the non-traditional group, despite the similarity of adult serum cholesterol levels, because the traditional group had been exposed to a high fat diet long enough to raise their serum cholesterols but not long enough to cause atherosclerosis.

This early-diet hypothesis is a possible, if somewhat tortuous explanation of the findings in this study, although there are no data to support it. This counter-hypothesis would have to be stretched a little to explain the comparative lack of association between dietary preference and serum cholesterol (34). The hypothesis would have to be stretched further to account for the fact that among those whose upbringing was traditional, those whose pattern of social assimilation in adult life was non-traditional had a higher prevalence of CHD than those who were not socially assimilated.

Although the above may appear to have taken the form of a 1:1 battle between cultural factors and diet for the prime role in explaining the disease differences, the conclusion should not be that "culture" is the exclusive winner. It should be rather that the Japan-US differences in dietary habits *may* be importantly related to the CHD differences, but it is clear that consideration of dietary factors alone leaves unexplained much of the disease differences.

Implications

To assess the possible implications of the findings of this study, it may be helpful to review the reasoning underlying it. Substantial international variations in the frequency of CHD occur for reasons other than differences in the established coronary risk factors (41). Among the factors that may account for these disease differences are differences in culture and social organization. The results from the study of men of Japanese ancestry living in Japan, Hawaii and California were consistent with the hypothesis that social and cultural factors play a role in the etiology of CHD independent of other risk factors. This hypothesis was tested further in the present study by confining attention to Japanese-Americans in California. The prevalence of CHD showed a strong association with the measures of acculturation that were developed, the most traditional group having one-fifth the prevalence rate of the most acculturated group. These findings were remarkably congruent with the findings of the wider Japan-Hawaii-California study, in that the most traditional group in California had a CHD prevalence rate approximately equal to the rate in Japan. By contrast, the most acculturated group in California had a prevalence rate that is comparable to that seen among Caucasian Americans. Further, this difference in CHD prevalence is not explained by differences in other coronary risk factors. In other words, by using only these acculturation indices, it is possible to distinguish subgroups of the California Japanese population that have differences in CHD prevalence that are as great as the difference between Japan and the United States.

The general hypothesis that certain cultures may be protective against coronary heart disease has thus survived the test of this study. This, of course, does not prove that cultural factors account for the CHD differences seen among various other migrant groups, such as migrants to Israel (42, 24), or other groups undergoing culture change (43–45). The results are, however, consistent with this possibility.

From the general concept of acculturation, it has proved possible to isolate particular cultural features that appear to be associated with the occurrence of CHD. More specifically, this study supported the suggestion that a stable society whose members enjoy the support of their fellows in closely knit groups may protect against the forms of social stress that may lead to CHD. There is also evidence from Hawaii that Japanese-Americans manifest the type A behavior very infrequently (46). The characteristics just described are not specific to Japanese culture, but characterize many tradition-oriented cultures, e.g., the observed low rates of CHD in Greece, Italy and Yugoslavia in the Seven Countries Study (38) may be in part a result of the persistence of strong family and other groups in many parts of those countries. Conversely, the high rates of CHD in the US and some countries of Northern and Western Europe might be in part due to the fact that these societies display almost opposite characteristics to the protective features described, i.e., lack of stability, accent on the individual rather than the group, and high likelihood of an individual finding himself in a situation for which his world-view has left him unprepared.

It would be a mistake to try and stretch the above social and cultural concepts to cover all the known variations in CHD occurrence, for to do so they would need to be twisted beyond recognition. For example, it is highly unlikely that social and cultural factors play any major part in the known propensity of diabetics to CHD or in the high frequency of CHD among people with certain familial lipid disorders. On the other hand, it is quite possible that the male/female ratio of CHD may be related to social factors, as might many of the geographic differences in CHD. It is also possible that in an individual who is predisposed to CHD for other reasons, social and cultural factors may put him at even higher risk. Certainly, there was a suggestion in this study that the relative prevalence seen with acculturation was a little higher in smokers and in men with high serum cholesterols than in men without these risk characteristics.

It is obvious that consideration of social and cultural factors alone do not explain the variations in other diseases. A major question that should be explored, is that of the possible interactions between social factors and other pathogenic influences in explaining variations in other chronic diseases such as stroke and many cancers.

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