Diet Composition in the Pacific Area in Relation to Cardiovascular Disease*

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THOUGH the causes of cardiovascular disease are many, yet the nutritional contribution to the possible causes of such disease has long been well established in beriberi heart disease and in atherosclerotic or degenerative cardio-vascular disease. In connection with the latter case, there have been numerous reports accumulated particularly within the last decade or so. Malnutrition can cause lowering of general resistance to infection. This may usher in infectious cardiovascular disease, such as rheumatic heart.¹⁾⁻⁴⁾ Therefore nutrition is practically found to be involved in all these three types of cardiovascular diseases, although it may not be the sole contributing factor to any one of them. The primary purpose of this paper is to analyze and to ascertain if the dietary composition of the Pacific area may have some relationship to cardiovascular disease, particularly atherosclerotic and degenerative cardiovascular disease, by firstly reviewing the existing knowledge on dietary constituents in relation to these diseases and then comparing the epidemiological findings on the incidence or death rate among different Pacific countries due to these diseases with their dietary patterns. Factors other than dietary that may cause the development of these diseases will not be included in this paper.

HYPERCHOLESTEROLEMIA AND ATHEROSCLEROSIS

It may be appropriate to mention here a little about hypercholesterolemia in relation to atherosclerotic heart disease before going to the other parts of this paper.

There have been voluminous reports concerning the metabolism of lipid and cholesterol. Most of them imply some relationship between hypercholesterolemia and atherosclerosis. Both in experimental and

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clinical atherosclerotic or degenerative cardiovascular diseases, hypercholesterolemia is almost always associated with it, though the mechanism of how does hypercholesterolemia affect the development of these diseases remains obscure.

Stare and his group⁵⁾ was able to produce atherosclerosis in Cebus monkeys and in rats by maintaining their serum cholesterol level at 300 mg.% and 500–600 mg.% for 4–5 and 8–11 weeks respectively. Myocardial infarction with mural thrombosis was also produced in 5 out of 9 rats on similar diet for 14 weeks.⁶⁾ Lowry and his associates⁷⁾ found in their study that serum cholesterol and lipoprotein level were highest in myocardial infarct, less in angina pectoris and least in normal cases. The recovery of large amount of cholesterol and many uncommon sudanophilia materials from atheroma of arterial wall was also reported.⁶⁾

However, serum cholesterol level may be considered as representing a dynamic equilibrium between the rate of introduction and the rate of removal of cholesterol from the blood.⁸⁾ Any factor which may cause the increase in biosynthesis or decrease in degradation of cholesterol in liver will cause the elevation of blood cholesterol level. Furthermore, wide spontaneous variation in serum lipids and cholesterol was observed in hypercholesterolemia patients,⁹⁾ as well as in normal individuals in response to specific stress.¹⁰⁾ It was reported¹¹⁾ that the feeding of unsaturated fat with cholesterol to piglets resulted in elevation of liver and coronary but not plasma cholesterol. For this reason, doubt is raised as to the diagnostic value of blood cholesterol level obtained by routine laboratory method.

However, this defect notwithstanding, the determination of blood cholesterol level remains to be the relatively reliable and convenient method to define the metabolic disorder that exist in ischemic heart disease.¹²⁾ Therefore, it is still the general trend that in speaking of hypercholesterolemia, that atherosclerosis is also meant to be present.

DIETARY FACTORS RELATING TO DEGENERATIVE CARDIOVASCULAR DISEASES

Many dietary constituents are correlated one way or another with the metabolic disturbance of cholesterol: hypercholesterolemia and clinical cardiovascular disease. One must remember that, under natural conditions, there are always several constituents of a diet acting together, either in synergism or antagonism, that would influence the development of such diseases. However, for the sake of convenience in presentation, these nutrients which are known to be correlated to these diseases will be discussed separately. Table I summarizes the possible dietary

Table 1. Effects and Possible Mechanism of Nutrients on Serum Cholesterol Level and Atherogenesis*

Nutrients	Cholesterolemia	Atherogenesis	Possible Mechanism
Fat & Fatty Acid:			
Saturated	+	+	Increasing biosynthesis of cholesterol. ¹³⁾ Slower catabolism and ready disposition of cholesterol esters in tissue—Atheroma. ¹⁴⁾ Increasing of blood coagulability. ¹⁴⁾⁻¹⁷⁾
Unsaturated	—	—	Less absorption. ¹⁸⁾ Faster cholesterol ester excretion. ^(9), 20)
Sterols:			
Cholesterol	+	+	Causing essential fatty acid deficiency. ²¹⁾ Increasing of lipogenesis. ^{14), 22)} Inhibition of fibrinolysis. ²³⁾
Plant sterol (Sitosterol)	—	—	Interfering with cholesterol absorption. ²⁴⁾
Protein:			
High intake	—	—	Improving liver function through lipotropic effect & increase of biliary excretion of cholesterol metabolites. ²⁵⁾ Increasing lipid transportation. ²⁵⁾
Low intake	+	+	Shortage of lipotropic material. Pronounced lipogenesis and possibly cholesterol catabolism in liver. ²⁶⁾
Carbohydrates:			
High intake	+	+	Lipogenesis.
Simple sugar*	+	+	Slower bile acid excretion. ²⁷⁾
Starch*	—	—	Faster bile acid excretion. ²⁷⁾
Fiber	—	—	Increasing gastrointestinal motility and less absorption of cholesterol and fat. ²⁸⁾ Changing intestinal flora and thus increasing turn over and slow down. The reabsorption of cholesterol and its metabolite. ^{28), 29)}
Vitamins:			
Pyridoxine	—	—	Increasing the conversion of linoleic acid to arachidonic acid. ^{14), 30)}
Nicotinic acid	—	—	Increasing cholesterol catabolism. ³¹⁾
Calciferol	+	+	
Ascorbic acid	—	—	
Minerals:			
Mg	—	—	Relating to lipoprotein metabolism. ^{32), 33)}
Co	—	—	Interference of cholesterol absorption. ³⁴⁾ Increasing cholesterol oxidation. ³¹⁾
Fe, Ni	—	—	Increasing cholesterol oxidation. ³¹⁾
Ca (High intake)		+	Calcification of atheroma lesion.
(Low intake)		—	Lessening calcification of the lesion.
I (Low intake)		+	Lessening cholesterol oxidation through hypothyroidism. ³⁵⁾

* Relatively in comparison between starch and simple sugar.

constituents and their mechanism of favoring or preventing from the development of degenerative cardiovascular diseases.

Fat and Fatty Acids:

Fat may be the most important dietary factor and the most carefully investigated of all food constituents which influence the development of hypercholesterolemia and atherogenesis. The intake of excessive calorie and high fat will result in obesity which is correlated with coronary disease.³⁶⁾ In such cases serum cholesterol level is often elevated.^{27), 37)} In addition to the quantity, the quality of fat in a diet may be more responsible for hypercholesterolemia.³⁸⁾ The early findings were that animal fats caused the elevation of serum cholesterol level while the vegetable oils acted in the reverse direction^{39) - 41)} with the exception of coconut oil.^{40), 42)} It was reported, and generally accepted that the degree of saturation of fat may play the main role in the development of hypercholesterolemia.^{37), 40), 42) - 48)}

However, in many cases, saturation alone offers no satisfactory explanation, as safflower oil and fish oil which are of higher degree of unsaturation yet possess less hypocholesterolemic effect than corn oil. Therefore, Kinsell⁴⁹⁾ and Sinclair¹⁴⁾ suggested and have been precisely demonstrated by Quackenbush and Paivlowaki⁵⁰⁾ that the essential fatty acid, linoleic acid, is the primary factor affecting serum cholesterol level. The hypocholesterolemic effect of corn oil is due to its high content of linoleic acid. This statement was proved directly by feeding animal with corn or other grain oil,^{43), 51)} while indirectly, the feeding of hydrogenated unsaturated fat or fatty acid to animals resulted in hypercholesterolemia.^{14), 48), 52) - 54)} Therefore, the high intake of saturated fat or cholesterol or both will increase the body need for essential fatty acid and so it may lead to a conditional essential fatty acid deficiency.^{13), 21), 54), 55)} Hypercholesterolemia will eventually be the result of chronic deficiency of essential fatty acid.^{14), 30)} Long-chain triglycerides^{14) - 18 C)} enhance essential fatty acid deficiency whereas medium chain triglycerides^{6) - 12 C)} have little effect.⁵⁶⁾

Keys and his group^{45), 57) - 59)} contend that neither the degree of saturation nor the linoleic acid content of the dietary fat alone offers a good explanation. The greater lowering effect of corn oil on hypercholesterolemia may be due to both of its essential fatty acid content and unsaturation. But Stare and his group⁶⁰⁾ demonstrated that non-essential unsaturated fatty acid may even promote hypercholesterolemia. Rathmann,⁴⁶⁾ however, suggested that the ratio of linoleic acid to saturated acid in a diet may be the critical variable rather than the absolute amount of linoleate.

Quite recently, Howard⁶¹⁾ has confirmed in rats that saturated fats are thrombogenic, but on the other hand, he has also demonstrated that essential unsaturated fatty acid may facilitate the deposition of cholesterol in tissues and thus it may also cause the production of atherosclerosis.

The mechanism of fatty acid in affecting the serum cholesterol level was suggested by Holman and his associates¹³⁾ that the absorbed fatty acids needed cholesterol and lipoprotein for their transportation in the blood stream. When the intake of saturated fat was of large amount or of long duration, polyunsaturated fatty acids may be released from tissue stores and cholesterol would have to be synthesized endogeneously to travel with saturated fat and to maintain homeostasis. Thus the serum cholesterol level thereby was elevated. Sinclair¹⁴⁾ suggested that serum cholesterol was rather easily esterified by hydrogenated saturated fatty acid. But the resulting esters become less readily to be disposed off and thus they cause atheroma. Therefore the faster removal of cholesterol^{19), 20)} and less absorption¹⁸⁾ after its being esterified with fatty acid from unsaturated fat than from saturated fat such as lard have been attributed as the mechanism of the lowering of serum cholesterol level by unsaturated fat or unsaturated fatty acids.

It was reported that phospholipid-change paralleled with that of the cholesterol.¹¹⁾ As cholesterol is needed for transporting fatty acid in blood stream,¹⁴⁾ so phospholipid may also be retained in plasma. The result of their presence may increase the coagulability of blood and thereby contributing to coronary thrombosis.

Similarly, it was reported that fibrinolysis was conspicuously inhibited after a fat-containing meal¹⁶⁾ or after eating butter,¹⁷⁾ though the degree of this inhibition varied from person to person.¹⁶⁾ However, in rabbit,²³⁾ clot in marginal vein of an ear would be lysed more slowly after a high cholesterol diet, 1 mg./Kg./day. Astrup¹⁵⁾ therefore suggested that fibrinolysis might be the possible pathogenic mechanism of atheroma after lipemia.

To summarize the foregoing discussion that the result of high intake of fat, especially prominent amount of saturated fat, is hypercholesterolemia and lipemia. Both of them may induce atherogenesis and inhibition of fibrinolysis which in turn increases blood coagulability and lead to thrombosis. While essential fatty acid, linoleic acid, (probably not all unsaturated fatty acids) is necessary to protect from hypercholesterolemia and atheromatosis.

Sterols and Cholesterol:

Dietary cholesterol level has direct effect on the serum cholesterol level in animals. It was reported that high cholesterol diet could cause

the elevation of serum cholesterol and betalipoprotein levels in dogs,⁶²⁾ and produce hyperlipemia and cardiovascular lesions in rats.^{22), 63)} Cholesterolemia would be produced in monkeys only when its dietary fat was supplemented with cholesterol.^{64), 65)} In atherogenic diets, cholic acid should be included to promote the absorption of cholesterol and the deposition of the latter in the liver.⁵⁴⁾

In a recent study by Reiser, Sorrels and Williams¹¹⁾ showed that high saturated fat (Myristic-lauric) diet had no significant effect on atheromatosis in piglets unless cholesterol was in the diet. Inclusion of cottonseed oil produced no lesions until cholesterol was added to the regimen. Numerous lesions produced by saturated fat plus cholesterol appeared to be fibrotic and calcified and poorly stained with Sudan IV. In contrast, the cottonseed oil plus cholesterol produced plaques that were deeply stained with Sudan IV, larger, fewer and more concentrated near orifices of the aortic branches.

Feeding of cholesterol to chicks on a low or high protein diet increases liver cholesterol concentration, stimulates fatty acid synthesis and decrease the proportion of protein in the liver.⁶⁾ All these are favoring lipemia and atherogenesis.

In man, it has been generally agreed that dietary cholesterol of normal range has only minor effect or no influence on serum cholesterol level,^{66) - 67)} unless the daily intake be increased to about 600 mg.⁶⁸⁾ Further increasing of cholesterol intake to 1,300-4,500 mg. daily results in no further significant change of the blood level.⁶⁸⁾ This is explained as that the excessive exogenic cholesterol may inhibit its biosynthesis,^{11), 31)} both in man and animal,⁶⁹⁾ or may block the way of conversion from beta-hydroxy-beta-methyl glutaryl CoA to mevalonic acid.⁷⁰⁾

On the other hand the feeding of plant sterol, as sitosterol, may reduce the cholesterol levels in serum, liver and aorta of rats and rabbits⁷¹⁾ and of chickens.⁷²⁾ This is explained to be due to the interference of sitosterol in the absorption of cholesterol.²⁴⁾

Protein:

Dietary protein also influences the serum cholesterol level and the development of atherogenesis. Most of the obtained in this field were from experimental animals.

Low protein intake with or without cholesterol in the diet, as Fisher⁷³⁾ demonstrated, caused a significant elevation of serum cholesterol level in roosters. The severity of hypercholesterolemia and atherogenesis in growing cockerels on atherogenic diet was found inversely proportional to the protein content of the ration.⁷⁴⁾ More myocardial infarction was developed in rats on atherogenic diet containing 12% casein than that containing 20%

protein.^{6), 75)} When the protein intake kept at 20% level by addition of soy protein to high sucrose, high fat and high cholesterol diet, cockerels was protected from severe hypercholesterolemia and atherogenesis.⁷⁶⁾ Conversely, reduction of protein intakes from 20 to 16 and to 10 percent by addition of sucrose to a high fat and high cholesterol mash markedly aggravated hypercholesterolemia and atherogenesis in cockerels.⁷⁶⁾

Fillinos⁷⁷⁾ demonstrated in rats that either below or above 10% of protein, casien or soy protein, in an atherogenic diet an increased degree of cardiovascular sudanophilia was noticed. In comparison on the quality of protein to the influence of cholesterolemia, it was found that rat on 20% casien diet showed a high serum cholesterol level than those on the same level of wheat, corn, or soy protein as the sole source of dietary protein.^{78), 79)} However, Kokatum and his associates⁸⁰⁾ demonstrated in chicks that a ratio between energy to protein (E/P) of a diet, the lower the better, determined the serum cholesterol level and total amount of carcass fat irrespective of the type of fat or protein in the diet.

It was reported⁸⁾ recently that when chicks on a low protein diet with or without cholesterol, the incorporation of acetate 1-C¹⁴ into liver cholesterol and fatty acids was higher than those maintained on high protein diet. While the initial uptake of acetate 1-C¹⁴ into serum cholesterol was also higher in bird on low protein diet, inspite of a significantly higher serum cholesterol level. The same authors pointed out the effect of low protein diet in stimulating biosynthesis of cholesterol even when cholesterol concentration in liver was high.

Sulfur containing amino acids as methionine⁷⁹⁾ and cysteine²⁶⁾ were also shown to possess the lowering effect of serum cholesterol level.

The above data indicate that a high intake of protein has a partial protective effect on atherogenesis by reducing the serum and tissue cholesterol level. The mechanism²⁵⁾ of this effect may be related to 1) the improved liver function, lipotropic effect and increasing biliary excretion of cholesterol metabolites, and 2) the higher level of protein in lipid transport factor in plasma. While the elevating effect of a low protein diet on the serum cholesterol level (in chicks) may be due to a combination of factors, such as shortage of lipotropic material, pronounced lipogenesis and possible cholesterol catabolism.⁸⁾

Carbohydrate:

The high caloric intake will result in hypercholesterolemia. If a man takes 2,000 calories in excess of carbohydrate, both the levels of serum cholesterol and lipoprotein will be elevated.⁶⁴⁾ The effect of carbohydrate intake in cholesterolemia was demonstrated in rat to a greater extent by refined sugar like glucose and sucrose than by starch.^{77), 81)} The results

may be explained on the ground of Portman's experiment²⁷⁾ on bile acid metabolism that starch causes more bile acid excretion than sucrose. As among disaccharides, lactose was shown to be more hypercholesterolemic and atherogenic than sucrose in rabbit.⁸²⁾ The carbohydrate metabolism was reported to be also abnormal in hypercholesterolemic and atherosclerotic patients.^{83), 84)}

Fibers, as cellulose, form another group of carbohydrate. They are present in relative large quantity in grains, legumes and vegetables and related to the absorption and excretion of lipid. Thus they in turn affect the cholesterol level of serum. The higher intake of fiber from diets of pure vegetarian in comparison to non-vegetarian was found responsible for a lower level of serum cholesterol in the former than in the latter, 206:291 mg.%.^{29), 39)} The rapid passage of fecal material which results from the higher intake of crude fiber has been advanced as the reason why Africans have relatively lower blood lipid than non-Africans.⁸⁵⁾ In addition to the acceleration of gastrointestinal motility and the change of bacterial flora in intestine, the high content of crude fiber in intestinal tract, may also affect the cholesterol metabolism. This interpretation was confirmed by Portman²⁸⁾ who found that the biological half-life of radiocholate from rats on regular chow, sucrose, sucrose with fiber and sucrose with sulfa drug to be 1.9, 5.6, 1.6 and 11.4 days respectively. Similarly the same author²⁸⁾ explained his result that the accelerated gastrointestinal tract motility would eliminate a large portion of unabsorbed bile acid and fat. The change of microflora in intestine could induce either a quick "turn over" of bile acid in entero-hepatic cycling or a slow reabsorption of bile acid by changing it into nonabsorbable desoxycholate. The action of chemotherapeutic agents on intestinal flora in causing hypercholesterolemia in animals has been confirmed by other workers.^{27), 31), 86)}

Vitamins:

Vitamins play a minor and indirect role in affecting the level of serum cholesterol. It was reported that pyridoxin is necessary for the conversion of linoleic acid to arachidonic acid.^{14), 30)} In monkey, the elevation of plasma lipid appears to be dependant upon the intake of B₆ and the quantity and types of fat in the diet.^{87), 88)} When a large dose of B₆ (400 mg./day) is given to diabetic subjects, a significant fall of serum cholesterol level was reported.⁸⁹⁾

Nicotinic acid in large dosage (over 1 Gm./day) was reported recently to be able to lower serum cholesterol level in normal subjects^{51), 90), 91)} and in atherosclerotic patients.⁹¹⁾ This action was interpreted as due to its action of accelerating cholesterol catabolism *in vitro* and *vivo*.³¹⁾

Ascorbic acid was reported to possess some degree of hypocholesterol-

emic action,⁹²⁾ while calciferol as being somewhat cholesterolemic.^{22), 92)}

In passing, it may be mentioned that thiamine is contributory to the development of beriberi heart disease. The cardiac manifestations due to the metabolic disturbances in B₁-deficiency, such as water retention, edema, and acidosis of heart muscle, will lead to heart insufficiency.⁹³⁾

Minerals:

Magnesium deficiency was found to occur in humans as well as in animals during the course of experimental atherogenesis with atherogenic diet.^{32), 75), 94)} High magnesium diet would lower the vascular sudanophilia under hypercholesterolemic condition in animals. Hellerstein⁹⁴⁾ suggested that the anti-sudanophilic effect of high dietary magnesium was probably related to lipoprotein metabolism. High magnesium diet will lower the heart score.⁹⁵⁾ A negative correlation of serum magnesium and cholesterol level has been shown in South African Bantu and European subjects.³³⁾

Cobaltous chloride was demonstrated to be able to lower the serum cholesterol level of cholesterol fed cockerels.³⁴⁾ The effect was thought to be due to its action in intestinal tract.

It was reported that in presence of ferric, cobalt or nickel ions mitochondria from rat liver could oxidize cholesterol to a greater extent *in vitro*.³¹⁾

The low intake of calcium has been attributed to be cause of less severity of atherosclerosis in African natives.⁸⁵⁾ Hypothyroidism due to low intake of iodine was thought to be partially responsible for the relative high serum cholesterol value and coronary mortality in Finlanders.³⁵⁾

Sodium, another important electrolyte, may be related to aggravate or initiate hypertensive heart disease and cerebral vascular accident^{96) - 98)} but may not relate to atherogenesis.

DIETARY COMPOSITION OF PACIFIC COUNTRIES

From the foregoing review of the existing knowledge of how the dietary factors possibly influence the blood cholesterol level and atherogenesis, there leaves little room for any one to doubt whether nutrition really plays one of the important roles relating to these diseases. We may now turn to analyze and to compare the dietary compositions of the Pacific countries in order to see if they are correlated to the epidemiological findings of such disease in the corresponding regions.

Dietary information of the Pacific area is incomplete and qualitative in nature. In certain instances one has to use data from one or two countries or territories to represent the whole area. While in other

instances the author has to convert the existing data by calculation to a form suitable for general comparison.

The dietary patterns of the Pacific area could be arbitrarily classified into four groups, namely; the Caucasian, the Latin American, the Oriental and the South Pacific Islands. Table II summarizes these four food patterns and Table III gives the energy distribution among fat, protein and carbohydrate of different Pacific diets available in the authors' hands.

Table II. Dietary Pattern of Pacific Area
(in Cal./Capita/Day and %)

Food items	1. Caucasian		2. Latin Amer.		3. Oriental		4. S. Pac. I.	
	CCD.	%	CCD.	%	CCD.	%	CCD.	%
Grains	770	23.2	1276	48	1667	74.6	0-45	0-3
Sago, Taro & Potatoes							1230- 1380	82-92
Potatoes	145	4.3	155	3	128	5.7		
Pulses	11	0.3	86	6	112	5.0		
Vegetables	67	2.0	59	2	48	2.3	30-60	2-4
Tomato & Fruit	107	3.2	62	2	22	1.0	120	8
Coconut							14-45	1-3
Sugar	552	16.5	385	14	19	0.8	15-45	1-3
Fats & Oils	556	16.7	283	10	48	2.2		
Meat & Poultry	774	23.2	186	7	88	4.0		
Milk & Dairy Products	260	7.8	145	6	3	0.1		
Eggs	45	1.4	18	1	9	0.4		
Fish & Sea-foods	45	1.4	27	1	87	3.9	0-75	0-5
Total Cal.	3332	100.0	2682	100.0	2231	100.0	1500	100.0

1. Data averaged from United States⁹⁹⁾ and White Australian.¹⁰⁰⁾

2. Chile.¹⁰¹⁾

3. Data averaged from Taiwan,¹⁰²⁾ Japan¹⁰³⁾ and Korea.¹⁰⁴⁾

4. South Pacific Island, Western New Guinea, Biak and Ajamarse Region.¹⁰⁵⁾

The Caucasian Diet:

This is the typical dietary pattern of the United States, Canada, White Australia, New Zealand, part of USSR (no data) and Caucasian immigrants to the other Pacific regions. It contains characteristically high energy, high fat and high protein with the respective values capita daily as 3,100-3,300 cal., 120-150 Gm., and 100-120 Gm. Most of the fat and protein are derived from animal origin. Grains and their products and sugar or candy are the important carbohydrate food items. Meat, poultry, egg, fish or marine food, milk and dairy products are freely used.

Table III. Distribution of Calorie in Percentage

Countries	Total	Fat						Protein		Carbo- hydrate
		Total	S.	Un.	S/Un.	Animal	Veg.	Total	Animal	
United States ⁽¹⁰⁶⁾⁽¹⁰⁷⁾	3,357	39.2	33.5	5.7		27.5	11.7	12	8.2	48.8
Australia ⁽¹⁰⁶⁾	3,307	37.9	34.7	3.2				11	7.3	50.7
Canada ⁽¹⁰⁶⁾	3,130	38.0	35.0	3.0					8.0	
New Zealand	3,370	39.8	37.6	2.2					8.2	
<i>Caucasian</i>	3,100- 3,300	37.47	35.2	3.7	9.5	27.5	11.7	11.5	7.9	49.8
Costa Rica ⁽¹⁰⁸⁾	2,705	12.0				8.3	3.7	10.8	2.5	77.2
Guatemala ⁽¹⁰⁸⁾	2,283	7.5				3.5	4.0	11.7	2.6	80.8
Peru ⁽¹⁰⁹⁾	2,281	11.4						8.7	2.0	79.9*
Chile ⁽¹⁰⁶⁾⁽¹⁰¹⁾	2,682	19.8	12.0	7.8		8.2	11.6	7.0	4.3	73.2*
Colombia ⁽¹¹⁰⁾	2,431	16.8	9.3	7.5		10.4	6.4	8.3	3.9	74.9*
<i>Latin American</i> #	2,500	13.5	10.65	7.65	1.3	9.3	9.0	7.7	4.1	74.05
China (Taiwan) ⁽¹¹¹⁾	2,440	15.0	2.3	12.7		4.6	10.4	14.0	2.0	71.0
Japan ⁽¹⁰⁶⁾	2,005	7.9	1.4	6.5					2.6	
Korea ⁽¹⁰⁴⁾	2,248	7.8	1.6	6.2		2.1	5.7	13.5	2.9	78.7
Philippine ⁽¹¹²⁾	3,068	13.9								
Thailand ⁽¹¹³⁾	2,000	13.0								
<i>Oriental</i> **	2,000- 2,500	11.4	1.85	9.45	0.2	3.35	8.0	13.7	2.45	74.85
<i>South Pacific Island</i> ⁽¹⁰⁵⁾	1,500									

* Around 10-20% of calories from sucrose.

Data averaged from Chile and Colombia.

** Data averaged from China and Korea.

Liberal amount of vegetable and fruits are provided, except in USSR, particularly in winter.

About 37.5% of total energy are derived from fat. The ratio between saturated to unsaturated fat is 9.5. Protein contributes 12% of total energy and 2/3 of it is of animal origin. Carbohydrate gives less than 50% of total energy. As most of the food items are rather refined to a high extent therefore the fiber content of such a diet is the least among all the four dietary groups.

Most of the above mentioned constituents of the diet are rather favorable to the development of atherosclerotic diseases, except the protein constituent which may be protective in point of quality and favorable in sense of quantity.

Latin American Diet:

It offers a moderate amount of energy around 2,500-2,700 cal. per capita daily derived about 20% or less from fat and oil and 74% from

carbohydrate mainly from wheat and other grains with 10–20% of total energy from sucrose. The protein content is relatively low, contributing only 7.7% of total energy. It contains almost similar amount of milk and dairy products and of legume as that of Caucasian and Oriental diets respectively.

Such a diet pattern covers an area of the Pacific Coast of Latin American countries and a part of Central American countries.

In comparison with the Caucasian diet, it is less atherogenic because of lower fat content, 18.3% of total energy, with a much favorable ratio between saturated to unsaturated fat, 1.3, similar amount of sucrose or other refined sugar and higher fiber content. On the other hand, it contains less amount of protein, only contributing 7.7% of total energy. The last named condition, however, may be favorable for atherogenesis. The dietary effect of Latin American diet pattern may be considered as less atherogenic than the Caucasian.

The Oriental Diet:

It can be considered as high carbohydrate, high protein, mainly vegetable, and low fat diet with a total energy value of 2,200–2,500 cal. per capita daily. It is composed mainly of rice and small amount of other cereals, fair amount of legume and vegetables with a small amount of animal food items and practically no dairy products. Vegetable oil is the main cooking fat. This diet pattern covers rice eating countries of West Pacific Regions.

Judging from the energy distribution among different calorie-nutrients, the Oriental diet may be even less conducive to atherogenesis than the Latin American diet. Only 11.4% of total calorie is derived from fat, of which the ratio between saturated to unsaturated is 0.2. Although more than 3/4 of the dietary protein is of vegetable origin yet its quantity yields as high as 13.75% of the total energy and with wide range of variety. This diet is also high in carbohydrate but lower in simple sugar and high in fiber content. Conceivably, with characteristics as such, the Oriental diet would be least atherogenic among all the three dietary patterns mentioned. However, the high consumption of table salt, about 15–25 Gm. especially in Japanese diet and low intake of animal protein may have some relationship to hypertension and infectious cardiovascular disease respectively.

The South Pacific Islands Diet:

It is composed mainly of starchy roots and sago varying from 82–93% of total calorie with additional small amount of vegetable, coconut, fruits, and little rice and other grains or legumes. Fishes and sea food are

included in the menus of those islanders who inhabit the coastal areas of the islands. No cooking fat is used. The total calorie intake daily per capita again depends on the location and varies from 1,450 cal. the lowest to approximately 3,000 cal. the highest with an average of around 1,500. The average intake of protein is about 35 Gm. per capita daily with less than half of the total, 16 Gm., of animal origin. The salt intake is extremely low. In some locality, it is even less than 100 mg. of sodium chloride. So "bush salt" is used in place or in addition. Fiber content of this diet is the highest among all the regional patterns.

This dietary pattern covers mainly the population groups who live on less technically developed small islands of the Middle South Pacific Region. Aborigines (100,114) and indigenous natives who inhabit in inland regions of the other parts of this area are more or less live on the similar diets.

It is certainly the least favorable for atherogenesis. But undoubtedly, it will cause malnutrition and other disorders. Based on such information, the prediction is, that the incidence of beriberi and rheumatic heart diseases will probably be more prevalent than atherogenic disease.

From the above analysis of the dietary intakes of the Pacific Area based upon limited information and incomplete data, it may still be safe to state that the Caucasian diet may favor the development of cholesterolemia and degenerative cardiovascular diseases most readily than the other three Pacific diets. The Latin American diet may stand next and then the Oriental and South Pacific Islands diets. The reverse order may be true for nutritional and infectious heart disease, though supporting data is incomplete or even lacking.

EPIDEMIOLOGICAL FINDINGS

To what extent does the correlation exist between the dietary composition and the prevalence of the cardiovascular diseases, particularly that of the degenerative type, as the assertion made above should be tested by existing epidemiological data.

Keys¹¹⁵⁾⁻¹¹⁹⁾ showed that countries where the death rate from coronary heart disease is low the average consumption of fat is less and the mean serum cholesterol level of the general population is low. Stare⁶⁴⁾ Tejada^{120),121)} and Scrimshaw¹⁰⁸⁾ have made a lot of surveys to compare the incidence, extent and severity of atherosclerosis and serum lipid of the United States, Costa Rica and Guatemala. The average serum cholesterol level is higher in North Americans (233 mg.%) than that in the Costa Ricans and Guatemalans (140 mg.%).⁶⁴⁾ For people over 40 years of age, there were 51 cases of myocardial infarction among 316

cases of unselected autopsies in New Orleans and only one out of 234 in Guatemala City.¹²⁰⁾ Mean atherosclerotic index¹²¹⁾ was found to be highest in the United States urban, intermediate in Costa Rica and lowest in Guatemala in each comparable age group.

The serum cholesterol level of North American women living in Guatemala city is slightly lower than that of those living in the United States.¹²²⁾ Likewise the Japanese who live in Japan, Hawaii, and California have demonstrated a significant difference in serum cholesterol level and frequency of atherosclerosis and coronary heart disease.¹²³⁾ These differences of serum cholesterol level and incidence of atherosclerosis observed may be possibly strong evidence for eliminating the racial factors from serious consideration and for confirming that the environmental factors particularly dietary, are being responsible.

It was reported¹⁰⁰⁾ that the White Australian consume about 37% of the total daily calories in form dominantly of butter and animal fat. This results in a rising incidence of coronary heart disease. While Australian New Guinea natives and aborigines who consume a large amount of vegetable have no or little threat of coronary heart. In Hawaii,¹²⁴⁾ it was reported that due to increased consumption of milk, butter and ice cream in recent years the incidence of coronary heart disease per 10,000 jumped from 114 in 1942-1946 to 215 in 1957-1959.

Pan American Health Organization¹²⁵⁾ reported that there was relatively high proportion of deaths from cardiovascular disease due to vascular lesion affecting the central nervous system in Chile, and due to "other diseases of the heart" in Mexico and Columbia. But arteriosclerotic and degenerative heart disease accounted for 60% of the total deaths from cardiovascular lesions in United States.

In Japan,¹¹³⁾ it was reported that the incidence of angina pectoris and myocardial infarction had risen steadily since 1930, declined during the last war years, 1943-1945, and again increased after 1950. In contrast to that of the U.S. and Canada, the death rate from ischemic heart disease in Japan is 9-10 times less but from cerebral vascular accidents 2-3 times higher.^{12), 113), 126)} The high intake of sodium chloride was considered as one of the cause of this higher death rate from hypertension with cerebral vascular accident.⁹⁶⁾

Table IV¹²⁷⁾ and Table V¹²⁸⁾ summarize and illustrate the above brief review on the frequency and incidence of degenerative cardiovascular diseases among the Caucasian, Latin American and Oriental population groups.

Although the data listed in Tables IV and V do not cover all the Pacific countries, yet they well illustrate the incidence of arteriosclerotic and degenerative heart diseases in accordance with the dietary pattern,

Table IV. Death Rate from Cardiovascular Disease per 100,000
Population in Age Group over 40*

	Total C-V D.	AHD. & DHD.		V-L Affecting C. N. S.		Other H. D.		Other C-V D.	
	Rate	Rate	%	Rate	%	Rate	%	Rate	%
U. S. A.	1254.8	762.3	60.8	284.9	22.7	33.9	2.7	173.7	13.8
Australia	1280.4	716.9	56.0	351.0	27.4	75.8	5.9	136.8	10.7
Canada	1134.9	683.9	60.2	281.1	24.7	36.4	3.2	133.5	11.9
New Zealand	1148.8	637.0	55.4	298.4	26.0	83.3	7.2	130.1	11.4
Costa Rica	594.9	242.1	40.7	150.3	25.2	106.0	17.8	96.4	16.3
Guatemala	281.7	118.4	42.0	85.8	30.4	56.1	19.9	21.3	7.7
Chile	676.9	200.7	29.5	251.2	37.1	99.9	14.7	125.0	18.7
Colombia	510.5	65.5	12.8	110.6	21.6	205.5	40.2	128.8	25.4
Mexico	441.2	38.9	8.8	80.5	18.2	286.6	65.0	35.2	8.0
Japan	857.0	157.4	18.3	579.4	67.6	58.8	6.9	61.4	7.2

* Puffer, R. R. and Verhoestraete, L. J.: Bull. W.H.O. 19: 315-324, 1958.

Table V. Mortality from Cardiovascular Disease per 100,000
Population in All Age Groups*

	Total C-V D.	AHD. & DHD.		V-L Affecting C. N. S.		Chronic R. H. D.		Syphilitic C-V D.	
	Rate	Rate	%	Rate	%	Rate	%	Rate	%
U.S.A. (White)	508.6	299.0	58.8	103.7	20.3	11.6	2.3	1.4	0.27
Canada (Excl. Yukon & N.W. Terr.)	401.9	226.6	56.4	90.6	22.5	9.6	2.4	0.7	0.17
Australia	476.9	251.9	52.8	121.6	25.4	8.2	1.7	1.2	0.25
Japan	235.7	43.9	18.6	139.0	59.0	3.6	1.5	0.7	0.3

* From WHO Epidemiological and Vital Statistics Report Vol. 12, No. 10, 1959.

AHD.: Arteriosclerotic Heart Disease; C.N.S.: Central Nervous System; C-V D.: Cardiovascular Disease; DHD.: Degenerative Heart Disease; R.H.D.: Rheumatic Heart Disease; V-L.: Vascular Lesion.

as predicted above. The ratios between Caucasian-Latin American-Oriental diet countries on the death rates of degenerative cardiovascular disease and its percentage are approximately 5:1.5:1 and 6:4:2 respectively (Table IV). While the ratios on the percentage of death rate from vascular lesions affecting central nervous system is approximately 1:1:2.5, though the Japanese situation may not be true for other Asiatic nations.

As early as 1941, Snapper¹²⁹⁾ suggested that the rarity of arteriosclerosis in North China might be explained on the ground of low cholesterol and high unsaturated fatty acid in the Chinese diet. In a recent

study from this laboratory¹¹⁾ it was found that the average value of serum cholesterol of Chinese in Taiwan is 159 ± 25 mg.% with a dietary fat intake of about 15% of total calories and 85% of this fat are vegetable oil. Record³⁾ from our teaching hospital showed that in 4,346 admissions to medical ward from January 1951 to September 1959, 632 cases were cardiovascular. Among these 632 cases, 274 were hypertensive patients, 43.35% of the total; 197 were of rheumatic heart disease, 31.17%; 83 were hypertension with cerebral vascular accident, 13.13%; and only 20 were of degenerative and arteriosclerotic disease, 3.16%. Reports from Mainland China,⁴⁾ showed that the incidence of atherosclerotic heart disease was also the lowest, with an average value of 7.9–10.4% of 3,541 and 2,751 cardiovascular cases in Shanghai and Peiping areas respectively. These data are shown in Table VI and are compared with some data of Caucasian in Shanghai and those of the U. S. A.

Table VI. Percentage of Incidence of Heart Disease in the Chinese

	Total cases	Athero-sclerotic	Hyper-tensive	Rheumatic	Others
Shanghai*	3,451	7.1	21.3	50.7	20.9
Peiping*	2,751	10.4	40.9	35.9	12.8
Taipei ³⁾	632	3.2	43.4	31.2	22.2
Caucasian* (Shanghai)	127	54.0	30.9	11.1	4.0
Boston*	3,000	48.5	26.2	23.5	1.8

* From Chinese Med. J. 77: 596-602, 1958.⁴⁾

Here again these data show that the percentage of incidence of atherosclerotic cardiovascular disease of all type of cardiovascular disease in Chinese is much less in comparison with that of the U. S. A., while that of the other type of cardiovascular disease including rheumatic and hypertensive heart disease are significantly higher in Chinese than in the Americans and Caucasian in China. The low incidence of atherosclerosis in Chinese was found to be more closely related to the low serum cholesterol level rather than to other factors. In another study of this laboratory¹³⁰⁾ on high caloric high fat intake population group, it was found that there was only a slight correlation between serum cholesterol level and blood pressure. The incidence of retinal arteriosclerosis was not significantly related to serum cholesterol level, but to age. Similar correlations were found in other studies.¹¹²⁾ However, in experimental hypertension it was indicated that hypertension might accelerate the elevation of serum cholesterol level⁶³⁾ and formation of atherosclerosis.¹³¹⁾

Jolliffe¹⁰⁶⁾ using other's data, calculated the correlation between the international death rate of coronary heart disease and certain environmental factors. He emphasized that the saturated fat of a diet remains the most important factor. With similar calculation it is found by the authors that the correlation between death rate of arteriosclerotic and degenerative heart disease of those countries listed in Table IV and total calories, total fat and saturated fat of the corresponding countries in Table III are +0.8965, +0.9437 and +0.9505 respectively. From these figures, the dietary fat, particularly saturated fat is found to be the most important factor. The total calorie intake seems to be less important than the others.

SUMMARY

The present status of knowledge of how dietary constituents may be related to the development of cardiovascular disease has been generally reviewed and discussed. The factors other than diet are not included in this paper.

Dietary patterns and composition of many Pacific countries have also been reviewed. They were arbitrarily classified into the following four groups.

(1) The Caucasian diet: It contains characteristically high energy (around 3,100–3,300 Cal. per capita daily), high fat (37.5% of total Cal.) with a ratio between saturated and unsaturated fat (S/U ratio) of 9.5, high animal protein and relatively low but refined carbohydrate. This is the typical dietary pattern of North American countries (excluding Mexico), White Australia, part of USSR and of Caucasian immigrants to the other Pacific regions.

(2) The Latin American diet: It offers a moderate amount of energy around 2,500–2,700 Cal. per capita daily, derived about 20% or less from fat with a S/U ratio of 1.3, and high carbohydrate content. Such a diet pattern covers an area of the Pacific Coast of Latin American countries and a part of Central American countries.

(3) The Oriental diet: It can be considered as a high carbohydrate, high protein, mainly vegetable, and low fat diet with a total energy value of 2,200–2,500 per capita daily. Only 11.4% of total calorie is derived from fat, of which the S/U ratio is 0.2. It is composed mainly of rice and other cereals, fair amount of legumes and vegetables, with a small amount of meat, poultry, fish and egg and practically no dairy products. Vegetable oil is the main cooking fat. This diet pattern covers rice eating countries of the West Pacific Region.

(4) The South Pacific Islands diet: It is composed mainly of starchy

roots, sago and taro, some coconuts and sea foods and a very little fat. So it is high in carbohydrate and fiber but low in protein and fat. This dietary pattern covers the population groups who live on less-technically developed small islands of the South Pacific Region.

Thus, the Caucasian diet may favor the development of cholesterolemia and of degenerative cardiovascular disease most readily than the other three Pacific diets. The Latin American diet may stand next and then the Oriental and South Pacific Islands diets. The actual situation runs parallel with this trend, as the ratios between Caucasian-Latin American-Oriental diet countries on death rate of degenerative cardiovascular disease and its percentage in all types of heart diseases are approximately 5:1.5:1 and 6:4:2 respectively. So the correlation between diet composition and cardiovascular diseases does exist.

From the study of correlation between the caloric percentage of consumed dietary constituents and the death rate of arteriosclerotic and degenerative heart diseases of many Pacific countries, it may be safe to say that, the dietary fat, particularly saturated fat is the most important factor in the development of these diseases.

But the reverse order may be true for infectious and nutritional heart diseases, though supporting data are incomplete.

Relevant data for the South Pacific Islanders are insufficient, therefore, whether the above statements hold true or not requires further proof.

REFERENCES

1. Padmavati, S.: *Am. Heart J.* **58**: 418, 1959.
2. Schrire, V.: *Am. Heart J.* **59**: 835, 1960.
3. Ting, N.: Selected Paper, National Defense Medical Center, 1957, 1958, 1959.
4. Tung, C. L., et al.: *Chinese M. J.* **77**: 596, 1958.
5. Clancy, R. E., Andrus, S. B., and Stare, F. J.: Seminar Report, 5;2, Merck and Co. Inc., 1960.
6. Hartroft, W. S. and Thomas, W. A.: *J.A.M.A.* **164**: 1899, 1957.
7. Lawry, E. Y., et al.: *Am. J. Med.* **22**: 605, 1957.
8. Nishida, T., Ueno, A., and Kummerow, F. A.: *J. Nutr.* **71**: 379, 1960.
9. Seqall, S. and Neufeld, A. H.: *Canada Med. Assoc. J.* **83**: 521, 1960.
10. Peterson, J. E., Wileox, A. A., Haley, M. I., and Keith, R. A.: *Circulation* **22**: 247, 1960.
11. Reiser, R., Sorrells, M. P., and Williams, M. C.: *Circulat. Res.* **7**: 833, 1959.
12. Bronte-Stewart, B.: Panel III, Lipids in Health and Disease, Fifth International Congress on Nutrition, Pp. 13-20, Washington, D. C., Sept. 1960.
13. Holman, R. T., Hayes, H., Malmros, H., and Wigand, G.: *Proc. Soc. Exp. Biol. & Med.* **96**: 705, 1957.
14. Sinclair, H. M.: *Lancet* **I**: 381, 1956.
15. Astrup, T.: *Lancet* **II**: 565, 1956.
16. Greig, H. B. W.: *Lancet* **II**: 16, 1956.

17. Buckell, M. and Elliott, F. A.: *Lancet* **I**: 662, 1959.
18. Portman, O. W. and Sinisterra, L.: *J. Exp. Med.* **106**: 727, 1957.
19. Byers, S. O. and Friedman, M.: *Proc. Soc. Exp. Biol. & Med.* **98**: 523, 1958.
20. Wilson, J. D. and Siperstein, M. D.: *Proc. Soc. Exp. Biol. & Med.* **99**: 113, 1958.
21. Holman, R. T. and Peifer, J. J.: *J. Nutr.* **70**: 411, 1960.
22. Wilgram, G. F.: *Proc. Soc. Exp. Biol. & Med.* **99**: 496, 1958.
23. Kwaan, H. C. and McFadzean, A. J. S.: *Nature, London*, **179**: 260, 1957.
24. Best, M. M. and Duncan, C. H.: *Am. Heart J.* **58**: 214, 1959.
25. Editorial: *Am. J. Clin. Nutr.* **8**: 251, 1960.
26. Mann, G. V.: *Am. J. Clin. Nutr.* **8**: 491, 1960.
27. Bergstrom, S.: Panel III. Lipids in Health and Disease, Fifth International Congress on Nutrition, Washington, D. C., Sept. 1960.
28. Portman, O. W.: *Am. J. Clin. Nutr.* **8**: 462, 1960.
29. Hardinge, M. G., Chambers, A. C., Crooks, H., and Stare, F. J.: *Am. J. Clin. Nutr.* **6**: 523, 1958.
30. Van Itallie, T. B.: *Am. J. Public Health* **47**: 1530, 1957.
31. Kritchevsky, D., et al.: *Am. J. Clin. Nutr.* **8**: 411, 1960.
32. Hellerstein, E. E., Nakamura, M., Hegsted, D. M., and Vitale, J. J.: *J. Nutr.* **71**: 339, 1960.
33. Bersohn, I. and Oelofse, P. J.: *Lancet* **I**: 1020, 1957.
34. Tennert, D. M., et al.: *Proc. Exp. Biol. & Med.* **98**: 747, 1958.
35. Roine, P., et al.: *Lancet* **II**: 173, 1958.
36. Mayer, J.: *Am. J. Public Health* **50**: 5, 1960.
37. Hegsted, D. M., Gotsis, A., and Stare, F. J.: *J. Nutr.* **70**: 119, 1960.
38. Keys, A.: Symposium on Fats in Human Nutrition, Council on Foods and Nutrition, A. M. A., Chicago, 1957.
39. Hardinge, M. G. and Stare, F. J.: *J. Clin. Nutr.* **2**: 1954.
40. Ahrens, E. H., Hirsch, J., Insull, W., Jr., Tsaltas, T. T., and Blomstrand, R.: Symposium on Fats in Human Nutrition, Council on Foods and Nutr., A. M. A., Chicago 1957.
41. Ahrens, E. H. Jr., Blankenhorn, D. H., and Tsaltas, T. T.: *Proc. Soc. Exp. Biol. & Med.* **86**: 872, 1954.
42. Ahrens, E. H., Jr., et al.: *Lancet* **I**: 943, 1957.
43. Pick, R., Stamler, J., and Katz, L. N.: *Circulation* **16**: 513, 1957.
44. Keys, A., Anderson, J. T., and Grande, F.: *Lancet* **I**: 787, 1957.
45. Keys, A., Anderson, J. T., and Grande, F.: *Circulation* **16**: 480, 1957.
46. Rathmann, D. M.: Unsaturated Fats and Serum Cholesterol, Corn Products Co., N. Y., 1958.
47. Hegsted, D. M., Andrus, S. B., Gotsis, A., and Portman, O. W.: *J. Nutr.* **63**: 273, 1957.
48. Lambert, G. F., et al.: *Proc. Soc. Exp. Biol. & Med.* **99**: 544, 1958.
49. Kinsell, L. W., Michaels, G. D., Frishey, R. W., and Splitter, S.: *Lancet* **I**: 334, 1958.
50. Quackenbush, F. W. and Pawlowski, M. D.: *J. Nutr.* **72**: 196, 1960.
51. Portman, O. W.: *Postgraduate Medicine* **26**: 386, 1959.
52. Beveridge, J. M. R.: *Fed. Proc.* **17**: 470, 1958.
53. Lewis, B.: *Lancet* **II**: 71, 1958.
54. Nath, N., Wiener, R., Harper, A. E., and Elvehjem, C. A.: *J. Nutr.* **67**: 289, 1959.
55. Holman, R. T. and Peifer, J. J.: *J. Nutr.* **70**: 411, 1960.
56. Peifer, J. J. and Holman, R. T.: *J. Nutr.* **68**: 155, 1959.
57. Armstrong, W. D., Pilsum, J. M., Keys, A., Grande, F., and Anderson, J. T.: *Proc. Soc. Exp. Biol. & Med.* **96**: 302, 1957.

58. Keys, A., Anderson, J. T., and Grande, F.: *Lancet* **I**: 66, 1957.
59. Keys, A., Anderson, J. T., and Grande, F.: *Lancet* **I**: 992, 1957.
60. Hegsted, D. M., Gotsis, A., and Stare, F. J.: *J. Nutr.* **63**: 377, 1957.
61. Howard, A. N. and Gresham, G. A.: *Proc. Nutr. Soc.* **19**: (2) XXIV, 1960.
62. Shull, K. H. and Mann, C. V.: *Am. J. Physiol.* **188**: 81, 1957.
63. Deming, Q. B., et al.: *J. Exp. Med.* **107**: 581, 1958.
64. Stare, F. J.: Forty Seventh Annual Meeting Medical Section of American Life Convention Pp. 170-182, June 1959.
65. Cox, G. E., Tayler, C. B., Cox, L. G., and Counts, M. A.: *Arch. Path.* **66**: 32, 1958.
66. Mann, G. V. and Stare, F. J.: Symposium on Atherosclerosis, NAS-NRC. P. 169, 1954.
67. Keys, A. and Anderson, J. T.: Symposium on Atherosclerosis, NAS-NRC. P. 181, 1954.
68. Beveridge, J. M. R., Connell, W. F., Mayer, G. A., and Haust, H. L.: *J. Nutr.* **71**: 61, 1960.
69. Taylor, C. B., Patton, D., Yogi, N., and Cox, G. E.: *Proc. Soc. Exp. Biol. & Med.* **103**: 768, 1960.
70. Siperstein, M. D.: *Am. J. Clin. Nutr.* **7**: 645, 1960.
71. Herrman, R. G.: *Circulat. Res.* **7**: 224, 1959.
72. Diller, E. R., Rose, L. L., and Harvey, O. A.: *Proc. Soc. Exp. Biol. & Med.* **104**: 173, 1960.
73. Fisher, H.: *Fed. Proc.* **18**: 525, 1959.
74. Stamler, J., Pick, R., and Katz, L. N.: *Fed. Proc.* **18**: 151, 1959.
75. Hellerstein, E. E., et al.: *J. Exp. Med.* **106**: 767, 1957.
76. Stamler, J., Pick, R., and Katz, L. N.: *Circulat. Res.* **6**: 447, 1958.
77. Fillios, L. C., et al.: *Am. J. Physiol.* **194**: 275, 1958.
78. Hsu, J. M., Willer, A., Yeh, S., and Chow, B. F.: *Fed. Proc.* **18**: 530, 1959.
79. Stamber, J., Pick, R., and Katz, L. N.: *Circulat. Res.* **6**: 442, 1958.
80. Kokatnur, M., Raud, N. T., and Kummerow, F. A.: *Circulat. Res.* **6**: 424, 1958.
81. Adams M., et al.: *Fed. Proc.* **18**: 178, 1959.
82. Wells, W. W. and Anderson, S. C.: *J. Nutr.* **68**: 541, 1959.
83. Waddell, W. R. and Field, R. A.: *Metabolism* **9**: 800, 1960.
84. Waddell, W. R., Geyer, R. P., Hurley, N., and Stare, F. J.: *Metabolism* **7**: 707, 1958.
85. Walker, A. R. P.: *Am. J. Clin. Nutr.* **7**: 499, 1959.
86. Broitman, S. A., et al.: *J. Lab. Clin. Med.* **55**: 55, 1960.
87. Emerson, G. A., et al.: *Am. J. Clin. Nutr.* **8**: 424, 1960.
88. Rinehart, J. F. and Greenbrey, L. D.: *Am. J. Path.* **25**: 481, 1949.
89. Faily, R. B.: *Circulat. Res.* **6**: 203, 1958.
90. Altschul, R., Hoffer, A., and Stephen, J. D.: *Arch. Biochem.* **51**: 558, 1955.
91. Galbraith, P. A., Perry, W. F., and Beamish R. E.: *Lancet* **I**: 222, 1959.
92. Myasknikov, A. L.: *Circulation* **17**: 99, 1958.
93. Keefer, C. S.: *Arch. Int. Med.* **45**: 1, 1930.
94. Hellerstein, E. E.: *Illinois Med. J. Vol.* **117**, No. 2, 1960.
95. Nakamura, M., Vitale, J. J., Hegsted, D. M., and Hellerstein, E. E.: *J. Nutr.* **71**: 347, 1960.
96. Dahl, L. K.: *Nutr. Rev.* **18**: 97, 1960.
97. Dahl, L. K. and Love, R. A.: *Arch. Int. Med.* **94**: 525, 1954.
98. Walker, A. R. P. and Grusin, H.: *Am. J. Clin. Nutr.* **7**: 264, 1959.
99. Sherman, H. C.: *Chemistry of Food and Nutrition*, 8th ed. P. 645, MacMillan, 1952.
100. Kirk, N., Hipsley, E. H., and Kefford, J. F.: Forty-year Review of Progress in Nutrition in Australia and the Territory of Papua/New Guinea, Australia Institute of Anatomy, Canberra, A. C. T., Australia, 1960.
101. Peterson, A. G.: Chile Background Information for Nutrition Survey Team. Inter-departmental Committee on Nutrition for National Defense, 1960.

102. Yang, Y. H. and Hsu, S. C.: A Preliminary Study on Taiwan Nutrition Requirement and Food Planning, J. C. R. R., Taipei, Taiwan. May, 1960.
103. Public Health and Welfare Ministry, Japan: Nutrition in Japan, 1954.
104. Chai, R. S.: Forth Years of Nutrition Progress in Korea, Ministry of Health and Social Affairs, Rep. of Korea, 1961.
105. Oomen, H. A. P. C.: The Nutrition Situation in Western New Guinea, P. 6, Dept. Royal Tropical Inst., Amsterdam, 1961.
106. Jolliffe, N. and Archer, M.: J. Chr. Disease **9**: 636, 1959.
107. Gore, I., et al.: Am. J. Path. **36**: 559, 1960.
108. Scrimshaw, N. S., et al.: Circulation **15**: 805, 1957.
109. Peru: Background Information for Nutrition Survey Team, Interdepartmental Committee on Nutrition for National Defense, Nat. Inst. Health, Bethesda, Maryland, 1958.
110. Columbia: Background Information for Nutrition Survey Team, Interdepartment Committee on Nutrition for National Defense, Bethesda, Maryland, 1960.
111. Chen, J. S. and Feng, S. W.: Chemistry **3**: 55A, 1959.
112. Carnara-Besa, S. F., et al.: Am. J. Clin. Nutr. **7**: 702, 1959.
113. Pollack, O. J.: Am. J. Clin. Nutr. **7**: 502, 1959.
114. Chen, J. S. and Huang, C. S.: Metabolism **9**: 594, 1960.
115. Bronte-Stewart, B., Keys, A., and Brock, J. F.: Lancet **II**: 1103, 1955.
116. Keys, A.: Am. J. Publ. Health **44**: 864, 1954.
117. Keys, A. and Anderson, S. C.: National Research Council, Publ. 338, P. 181, Washington, 1954.
118. Keys, A., Fidanza, F., Scardi, V., and Bergami, C.: Lancet **II**: 209, 1952.
119. Keys, A., et al.: Metabolism **3**: 195, 1954.
120. Tejada, C. and Gore, I.: Am. J. Path. **33**: 887, 1957.
121. Tejada, C., Gore, I., Strong, J. P., and McGill, H. C., Jr.: Circulation **18**: 92, 1958.
122. Mendez, J., et al.: Am. J. Clin. Nutr. **7**: 590, 1959.
123. Keys, A., et al.: Ann. Int. Med. **48**: 83, 1958.
124. Larsen, N. P.: Personal Communication.
125. Pan American Health Organization and the WHO in the Americas: U. S. Government Printing Officer, Washington, 1960.
126. Bortz, W. and Larsen, N. P.: Geriatrics **12**: 598, 1957.
127. Puffer, R. R. and Verhoestraete, L. J.: Bull. Wld. Hlth. Org. **19**: 315, 1958.
128. WHO Epidemiological & Vital Statistics Report.: Vol. **12**, No. 10, 1959.
129. Snapper, I.: Chinese Lessons to Western Medicine, N. Y., 1941.
130. Chen, J. S. and Kiang, T. M.: Chinese M. J., Rep. of China **7**: 225, 1960.
131. Fisher, E. R., Creed, D. L., and Baired, W. F.: Lab. Invest. **7**: 231, 1958.