EPIDEMIOLOGY OF CARDIOVASCULAR DISEASES IN ASIAN-PACIFIC REGION

CARDIOVASCULAR EPIDEMIOLOGY IN POLYNESIANS IN THE PACIFIC

By Ian Prior

INTRODUCTION

The detailed study of Polynesians living within New Zealand and the Pacific offers a unique opportunity to test important hypotheses relating to some of the major problems of cardiovascular health and disease that beset so many societies in epidemic form today. This applies particularly to hypertension and coronary heart disease.

Work already carried out has shown a remarkable gradient relating to these disorders in different groups of Polynesians which relates to the extent to which they have moved from their traditional subsistence economy towards absorption into societies where they are exposed to the plethora of food and patterns of living that we regard as the norm in Western societies.[1,2,3]

The heavy and growing price they are paying for this, in terms of being at high risk for coronary heart disease, hypertension, diabetes, hyperuricaemia, and clinical gout, is seen in the very high rates of these disorders in the New Zealand Maori.[4,5]

Dr. Z. Fejfar, of the Cardiovascular Disease Unit, World Health Organisation, in his paper at this Congress referred to the ecological concept of man reacting to many factors in his environment. The evidence to be presented supports the hypothesis that these disorders represent a serious state of biological mal-adjustment to environmental changes, and as such must come in the realm of preventive medicine.

One of the key questions to be tested is whether an increase in blood pressure with age is inevitable, or whether there are a number of identifiable risk factors that play a part in controlling the level which the blood pressure level of an individual or group achieve.

Dr. William Miall has put forward the important hypothesis that the level of blood pressure achieved over a period of time is related to the starting pressure, and that levels below 130/80 in early adult life will not be associated with blood pressure elevation over a period of time.

The mechanism is thought to be self perpetuating once higher pressure levels develop.[6]

Attention is drawn to this important concept as it is capable of being tested by long-term studies and should be studied in a variety of populations including those in whom little or no blood pressure increase occurs with age, and in those where hypertension is a major problem such as the New Zealand Maoris.

It is becoming increasingly apparent that many disorders relating to ill health have a "fabric of causes" and a "fabric of effects" and it is the exciting function of multidisciplinary epidemiological studies to disentangle these as part of an ecological study of man and his environment. This is leading to a revitalising of the concepts, discipline and scope of human biology.

Pacific Demography

Many exciting demographic events are occurring in the Pacific in terms of population increase and migration.

The total population of Polynesians in New Zealand and the Pacific is around 800,000 and New Zealand Maoris constitute the largest number. A major migration from rural to urban areas has occurred in the past 30 years with 60 per cent of the Maori population now urban as compared to 15-20 percent 30 years ago.

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The Maori population of Auckland, the largest city in New Zealand, has increased from 6750 in 1951 to 60,000 in 1971. The population in New Zealand of Pacific Island Polynesians from the South Pacific has increased from around 1900 in 1945 to 3700 in 1951 to an estimate of 45,000 in 1971. They comprise, in 1971, 23,000 from Western Samoa, 16,000 from the Cook Islands, 5,000 from Nuie, and 1700 from the Tokelau Islands.

Scope of present paper

Cardiovascular epidemiological studies in New Zealand and the Pacific have been carried out by the Wellington Hospital Unit since 1962, as well as by other groups. Reference will be made to some of this work, particularly in relation to blood pressure. This presentation will also review some of the data collected concerning cholesterol and triglyceride levels and lipoprotein patterns in these groups. Reference will also be made to trace element studies. Finally, attention will be drawn to a major prospective study being undertaken of Tokelau Islanders on their home islands and following migration to New Zealand—The Tokelau Island Migrant Study.[1]

The blood pressures fall into several groups, with those in atoll dwellers from Pukapuka in the Northern Cook Islands, and the Tokelau Islands showing little increase in blood pressure with age. Easter Islanders, also Polynesians, studied by a Canadian team were found to show little increase of blood pressure with age.[7] This contrasts with samples studied in Rarotonga where living on a high island with greater exposure to Western life style, calories, and diet pattern is associated with a remarkable increase in blood pressure with age that is similar to that seen in New Zealand Maoris. At present no epidemiological studies have been carried out in Tonga or Samoa.

Mortality Data

Mortality data is available for New Zealand Maoris, but only limited data is available regarding the other groups.[8]

Table II shows a fourfold higher death rate from coronary heart disease in New Zealand Maori females in 45-54 age groups as compared to European females in the same age group. The high rate of 237 for the 45-54 year age group compared with 285 in New Zealand European and 295 for New Zealand Maori males is a remarkable situation.

Hypertensive Heart Disease

Table III shows that hypertensive heart disease deaths in the same age groups are occurring 9-12 times more frequently in Maori females as compared to European females and males, and are double that of the *Maori males.*

Significant Hypertension Prevalence Data

The different prevalence rates of significant hypertension, blood pressure 160/95 and over, are shown in Table IV for the following groups: New Zealand Maori; Rarotongans; Pukapukans; and Tokelauans.

A comparison of the mean systolic and diastolic pressures in age groups for the same populations is shown in Figs. 1 and 2.

Hypertensive Heart Disease

Criteria for hypertensive heart disease adopted are as follows:—

Definite: B.P. 160/95 one or both, with E.C.G.,
Minnesota code 3·1, 4 and or 5

TABLE I

PACIFIC DEMOGRAPHIC DATA

Pacific Polynesian Populations	
New Zealand Maori	230,000
Western Samoa	145,000
Tonga	90,000
French Polynesia	72,000 (1961)
American Samoa	30,000
Cook Islands	21,200
Ellice Islands	5,782
Nuie	5,000
Tokelaus	1,655
Easter Island	1,000
Non Maori Polynesians in New Zealand	58,000
Hawaiians and part Polynesians	70,000

TABLE III

NEW ZEALAND MORTALITY FROM HYPERTENSIVE HEART DISEASE 1950-1969
AGE/SEX/RACE SPECIFIC RATES
PER 100,000 MEAN POPULATION
(Mean annual rates for quinquennial periods)

	European							
	Male				Female			
	35-44	45-54 years	55-64	65+	35-44	45-54 years	55-64	65+
1950-54	4	14	62	241	3	14	66	310
1955-59	1	7	39	192	2	8	36	246
1960-64	2	5	17	125	1	5	17	170
1965-69	1	5	23	95	1	3	10	125
		Maori						
1950-54*	—	—	—	—	—	—	—	—
1955-59	6	35	48	281	22	71	203	319
1960-64	8	30	72	244	19	62	121	269
1965-69	4	34	94	209	11	64	129	194

*Maori data not available

TABLE II

NEW ZEALAND MORTALITY CORONARY HEART DISEASE 1950 - 1969
AGE/SEX/RACE SPECIFIC RATES PER 100,000 MEAN POPULATION
(Mean annual rates for Quinquennial periods)

	European							
	Male				Female			
	35-44	45-54 years	55-64	65+	35-44	45-54 years	55-64	65+
1950 - 54	39	203	628	1483	8	46	195	805
1955 - 59	43	216	648	1816	8	44	202	996
1960 - 64	57	271	766	2270	9	57	234	1283
1965 - 69	66	285	874	2547	15	63	284	1462
		MAORI						
1950 - 54*	—	—	—	—	—	—	—	—
1955 - 59	35	237	632	1556	38	193	415	969
1960 - 64	34	243	654	1746	35	195	514	1333
1965 - 69	84	295	877	2385	49	237	654	1671

*Maori data not available.

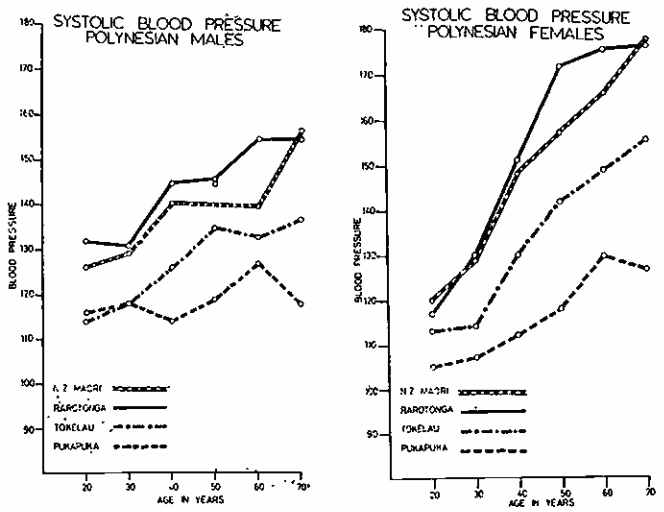

Fig. 1. Systolic blood pressure, males and females, in four Polynesian groups.

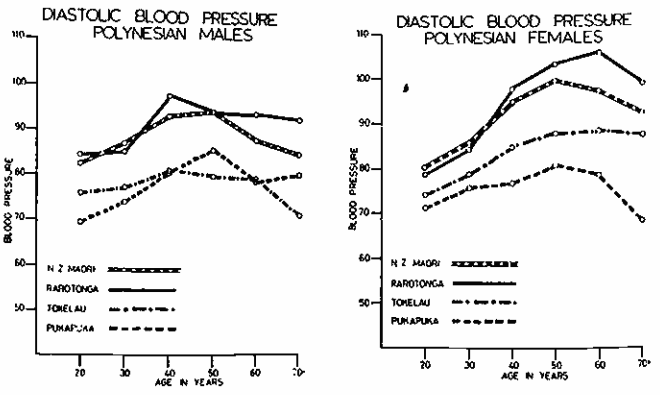

Fig. 2. Diastolic blood pressure, males and females, in four Polynesian groups.

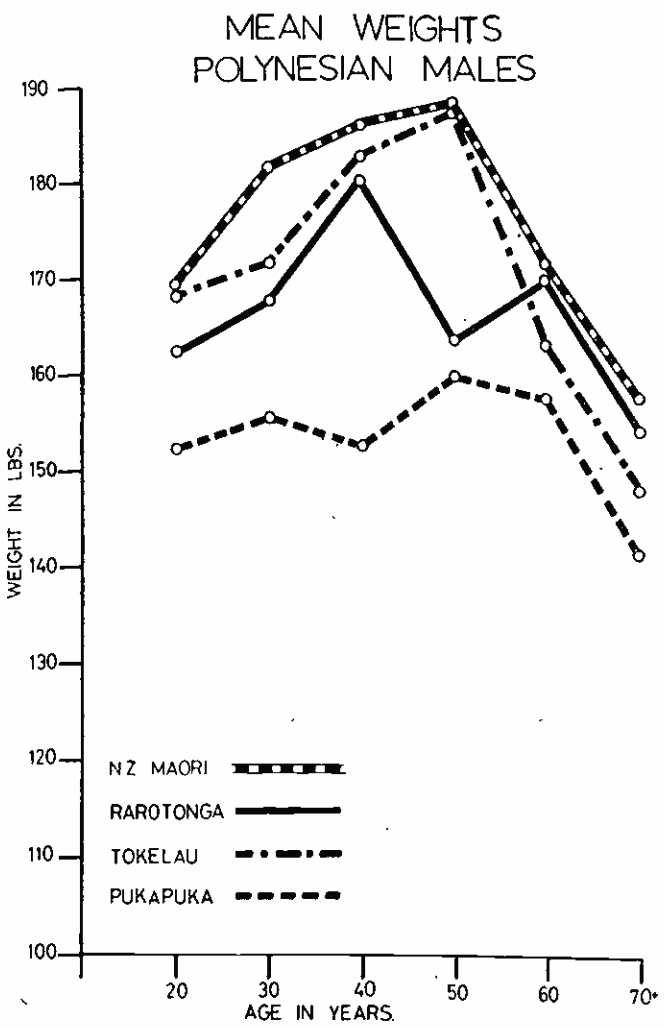

Fig. 3. Mean weights in lbs in four groups of Polynesian males.

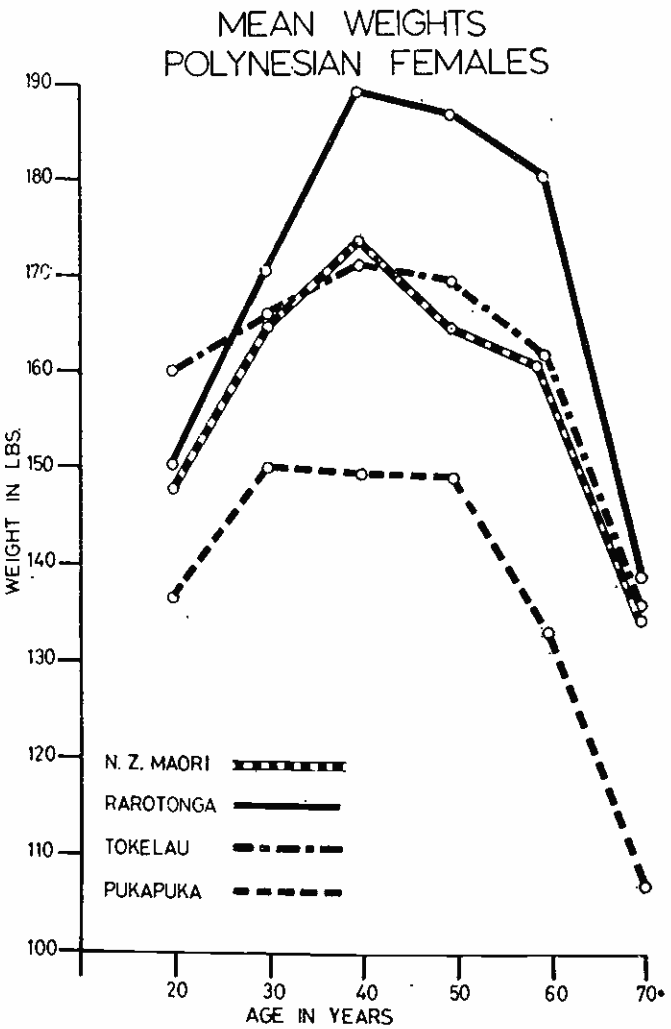

Fig. 4. Mean weights in lbs in four groups of Polynesian females.

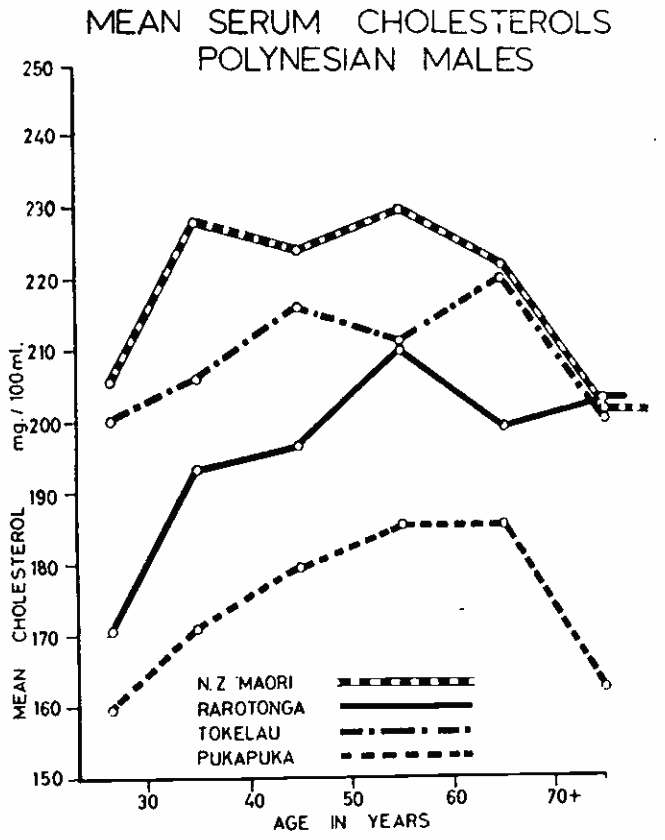

Fig. 5. Mean cholesterol levels in four groups of Polynesian males.

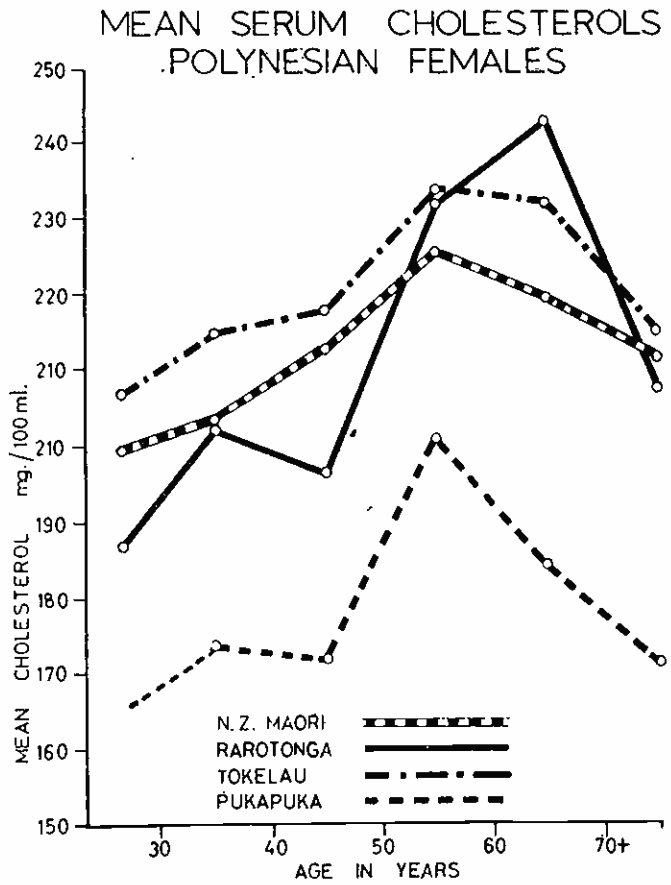

Fig. 6. Mean cholesterol levels in four groups of Polynesian females.

TABLE IV

PREVALENCE OF SIGNIFICANT HYPERTENSION 160/95 AND OVER IN FOUR POLYNESIAN GROUPS AGED 30 AND OVER

	Males %	Females %
Pukapuka	2	4·4
Fakaofo (Tokelau Is.)	8	10·5
New Zealand Maori	17	25·0
Rarotonga	21	36·0

TABLE V

HYPERTENSIVE HEART DISEASE—DEFINITE

$\frac{160}{95}$ one or both	Minnesota Code 3·1 and 4·1, 4·2 or 4·3 or 5·1, 5·2 or 5·3		
	Males		Females
Pukapuka	Nil		Nil
	188	379	191
Fakaofo	Nil		Nil
Tokelau Island	109	270	174
N.Z. Maori	4		3
1st Round	370	755	385
Deaths in 6 years, 4M 2F.			

TABLE VI

ANGINA—PHYSICIAN'S ASSESSMENT

	Males	Females
Pukapuka	3	2
	188	191
Fakaofo (Tokelau Is.)	2	4
	109	174
Rarotonga	7	8
	243	228
N.Z. Maori	14	44
2nd Round	351	382

Probable B.P. 160/95 one or both, E.C.G. code with 3·1 or 3·3

providing subject aged 35 and over

Possible: B.P. 160/95 one or both, with E.C.G. code 4 or 5.

Using these criteria definite hypertensive heart disease did not occur in either the Pukapukan or Tokelauan samples but was found in 4 of 370 Maori males and 3 of 385 Maori females aged 20 and over. See Table V.

Weight Changes

The mean weights of the same groups, New Zealand Maori, Rarotongans, Pukapukans, and Tokelauans, are shown for the males in Fig. 3 and for females in Fig. 4.

The gradient between the different groups follows the same pattern as the blood pressures, and weight is clearly an important factor contributing to the blood pressure pattern.

The differences in weight and blood pressure between the atoll dwelling Pukapukans and Tokelauans are of considerable interest. The fact that the Tokelauans are 15-20 lbs heavier than the Pukapukans is thought to contribute to their higher blood pressures. The Tokelauan levels of blood pressure are still notably lower, however, than the Rarotongans and New Zealand Maoris.

Salt Intake

We have previously reported the notably lower 24-hour sodium output of the Pukapukans compared to Rarotongans and New Zealand Europeans, and further studies on the Tokelau islands in 1971 confirmed their 24-hour output to also be in the 40-50 m.Eq. range. This compares with 24-hour sodium outputs of 120 m.Eq. in Rarotonga and 120-130 m.Eq. in New Zealand Maori groups.[9]

It is suggested that habitual salt intake plays an important part in the fabric of causes contributing to and helping set the blood pressure level of the individual and of populations. Further work is being carried out, testing this hypothesis.

Clinical Ischaemic Heart Disease

Based on physician's diagnosis of angina a wide gradient was found between the atoll dwellers and the New Zealand Maori subjects, the data from the latter represents the findings at the second round of studies carried out 6 years after the first round. The rate of 11·4% for Maori females compared with 4% for Maori males is to be noted.

The use of the Rose questionnaire, particularly in the island populations, revealed a number in whom certain features of the pain and the presence of spinal tenderness led to the diagnosis of skeletal chest pain.

Serum Cholesterol Levels

Serum cholesteral differences are shown in Figs. 5 and 6. The most important differences were found between the two atoll dwellers with the Tokelauans having significantly higher levels than the Pukapukans. Both groups are on a subsistence economy and traditional atoll diet comprising fish, coconut in many and varied forms, a limited amount of taro which does not grow very readily owing to the lack of soil, and breadfruit in the case of the Tokelauans. The Tokelauans use more of their resources and obtain 56 percent of calories from fat compared to 36 percent from fat in Pukapuka. In both groups 80 percent of their fat intake is derived from the highly saturated fat of the coconut.

Fat biopsies from both groups have shown high levels of C_{12} C_{14} and C_{16} short chain fatty acids.[11] Their egg intake and cholesterol intake is low.

Triglyceride and Lipoprotein Levels, Diabetes and Gout

The triglyceride levels are of considerable interest with levels ranging from low to very high in the different groups. The extraordinary extent of hyperuricaemia, gout, obesity, and diabetic abnormality reported from the first round of New Zealand Maori studies, carried out in 1962 and 1963 and confirmed in the second round of studies in 1968 and 1969, highlight a most important aspect of the Maori and Polynesian metabolic maladjustment. They contribute also to

TABLE VII

LIPOPROTEIN DISTRIBUTION—N.Z. MAORI MALES

	Normal	2a	2b	4	5
GOUT	9	8	12	8	3
N = 40	22·5%	20·0%	30·0%	20·0%	7·5%
DIABETES	7	6	9	4	2
N = 28	25·0%	21·4%	32·1%	14·3%	7·1%
NON GOUTY	56	32	18	22	2
NON DIABETIC					
N = 130	43·1%	24·6%	13·8%	16·9%	1·5%

their high risk status for vascular disease and hypertension. The notably higher triglyceride levels in the diabetic and gouty New Zealand Maori subjects as compared to the non diabetic and non gouty illustrate the way in which these disorders may play a key part in their high risk status.

The linkage between hyperuricaemia, hyperglycaemia, hypertriglyceridaemia and hypertension, or the 4-H syndrome, is being further explored by multivariate analysis in these groups.

In 1964 the triglyceride levels in Pukapukans were shown to be 0·93 m.Mols. ± 0·49 in males and 0·83 m.Mols. ± 0·45 in females (mean ± 2 S.D.). The levels in non gouty, non diabetic Tokelauans were 0·52 m.Mols. ± 0·24 in males and 0·56 m.Mols. ± 0·33 in females. These can be compared with levels in New Zealand non gouty, non diabetic Maori is of 1·83 m.Mols. ±1·92 in males and 1·42 m.Mols. ± 0·90 in females.

Data is available from the second round New Zealand Maori studies in the sample of 248 men aged 20 and over, 39 men with. gout had levels 3·28 m.Mols ± 3·12 and 28 with diabetic abnormality had levels 3·12 m.Mols. ± 2·63.

The levels in the diabetic Maori females were 1·83 m.Mols. ± 0·87 while the Tokelauan diabetic females had levels of 0·81 m:Mols. ± 0·38, both of these being higher than the normal control values.

The close relationship between gout and diabetes is shown by the fact that 15 Maori men had both disorders, the diabetes usually coming on some years after the gout.

Lipoprotein analysis, using Hatch Fredrickson Method, was carried out in the Tokelaus in 1968 and in the second round Maori studies in 1968 and 1969. Strips have been analysed and classified taking the cholesterol and triglyceride levels into account as recommended by World Health Organisation. In the Tokelaus a small number of 2A's were found but 2B and 4 were rare, and 5 did not occur at all.

This contrasts with New Zealand Maori males group, where 45 percent of non gouty, non diabetic had normal patterns as compared to 23 percent with a normal pattern in those with gout, and 25 percent in those with diabetes.

Type 2B or 4 abnormalities indicating elevated V.L.D.L. or endogenous triglycerides were found in 50 percent of gouts, 46 percent of diabetics and 30 percent of the non-gouty, non diabetic subjects.

The details are set out in Table VII for the New Zealand Maori males.

Diet Patterns

The diet patterns in some of the groups has been reported.[1]

The outstanding features that relate to differences observed between the groups include differences in total calories, fat intake, particularly highly saturated, short chain, fatty acids from coconut, and refined and complex carbohydrate intake.

The Pukapukans have the lowest overall calories and fat intake, but were using more flour and rice than the Tokelauans, giving them round 225 g. carbohydrate daily with only 9 g. daily as sucrose.

The Tokelauans have a higher fat intake and calorie intake as already described, a carbohydrate intake of around 167 g. daily and a low refined sugar intake of around 7 g./day. The egg intake of both groups is very low. Analysis of fat of chicken and pigs from the two islands show that it is very high in the short chain C_{12} Lauric and C_{14} Myristic fatty acids.

The New Zealand Maori have the highest calorie intake, the highest total fat intake getting 44 percent of calories from fat, and the highest carbohydrate intake of 284 g. daily. Their sucrose intake was 71 g. daily, which is high.

The higher carbohydrate intake of the Pukapukans could contribute to the higher triglyceride levels that they show as compared to the Tokelauans , while the high fat, high carbohydrate, high sucrose intake of the New Zealand Maori must play a part in their disorder characterised by the high rate of type 2B and 4 lipoprotein abnormalities.

Trace Element Studies

Water samples from the Tokelaus show the water to be extremely soft and pure. Tokelau urinary cadmium output per 24 hours was found to be 8-10 µg. which is around half that found in a sample of New Zealand adults.[10]

Analysis of soil and other trace elements is being undertaken.

The interesting question can be posed as to whether an habitually low exposure to cadmium is another factor contributing to the "Fabric of Causes" of blood pressure level that is achieved. Analysis of soil and serum samples for a wider range of trace elements is being undertaken.

Tokelau Island Migrant Study

The Tokelau Island Migrant Study, involving a prospective survey of Tokelau Islanders living on their home islands and those who have migrated to New Zealand, has been developed as a multidisciplinary study to answer certain specific questions relating to the process of migration, and the adaptation process involved in moving from their traditional isolated atoll life to the hurry, bustle and cash economy of urban New Zealand.

The hypotheses relate to whether some individuals will develop an increased susceptibility to sickness, changes in pattern of weight, blood pressure, diabetic status, and blood lipids in response to situations which can be identified as stressful.

The study has a major advantage in that almost the total population of living Tokelauans will be included, and that many of the subjects have been examined in a detailed way on their home islands prior to their making the decision to migrate to New Zealand. The survey includes 1650 subjects on their home islands and 1700 in New Zealand. Infants and children are being studied as well as adults.

CONCLUSIONS

The high price being paid by the New Zealand Maori, in terms of morbidity and mortality from a range of cardiovascular and metabolic disorders and the contrast with the picture seen among atoll dwellers, gives a clear indication of how exposure to the ways and diet of Western society can influence health and disease patterns.

The chance to observe in detail an "experiment of nature", the acute migration of Tokelauans to New Zealand is a unique opportunity, and should enable a variety of hypotheses to be tested and new knowledge gained.

ACKNOWLEDGEMENTS

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