STUDIES ON THE EPIDEMIOLOGY OF DIABETES IN PACIFIC POPULATIONS

SUPPLEMENTARY VOLUME OF TABLES AND FIGURES

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Due to the size of many of the tables in this thesis, all tables and figures were placed at the end of the manuscript.

For the convenience of the reader, a supplementary volume of tables and figures accompanies each copy of the thesis. The contents have been collated in the exact order in which they appear in the text.

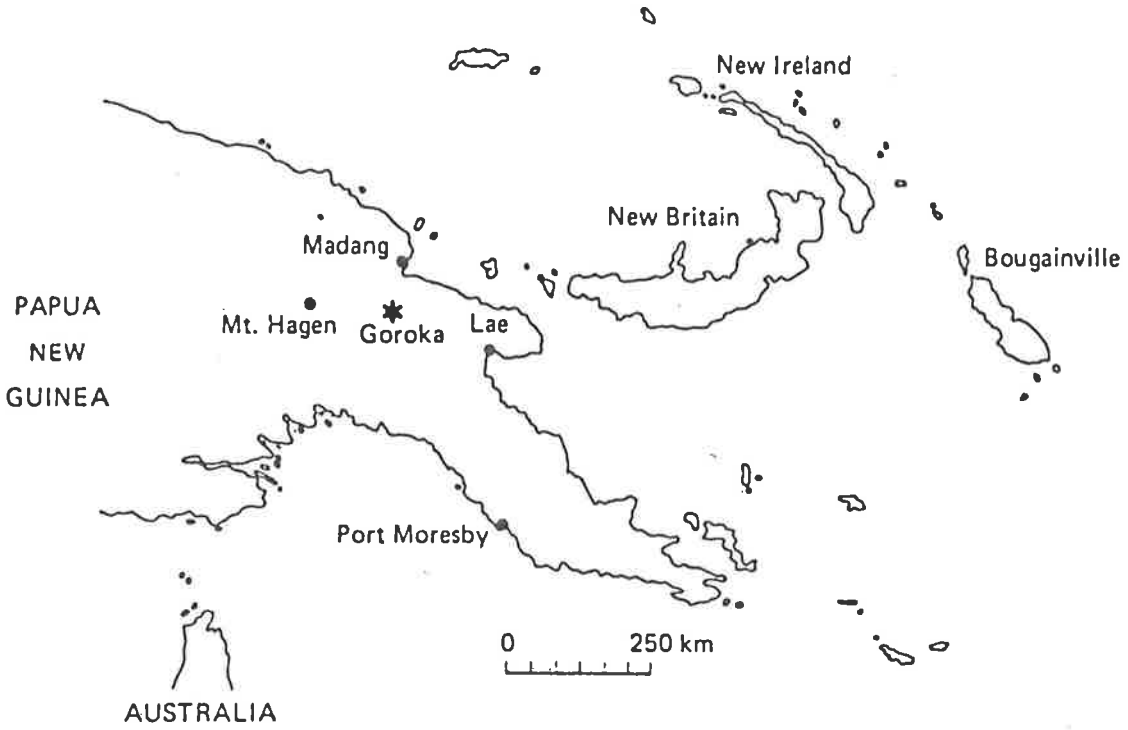

FIGURE 1.1: Map of Papua New Guinea

TABLE 1.1: Response rates. Asaro Valley diabetes survey, Papua New Guinea, 1983

Village	Available population	Responders	Response rate (%)
Gamusi	192	188	98
Gimisave	132	120	91
Total	324	308	95

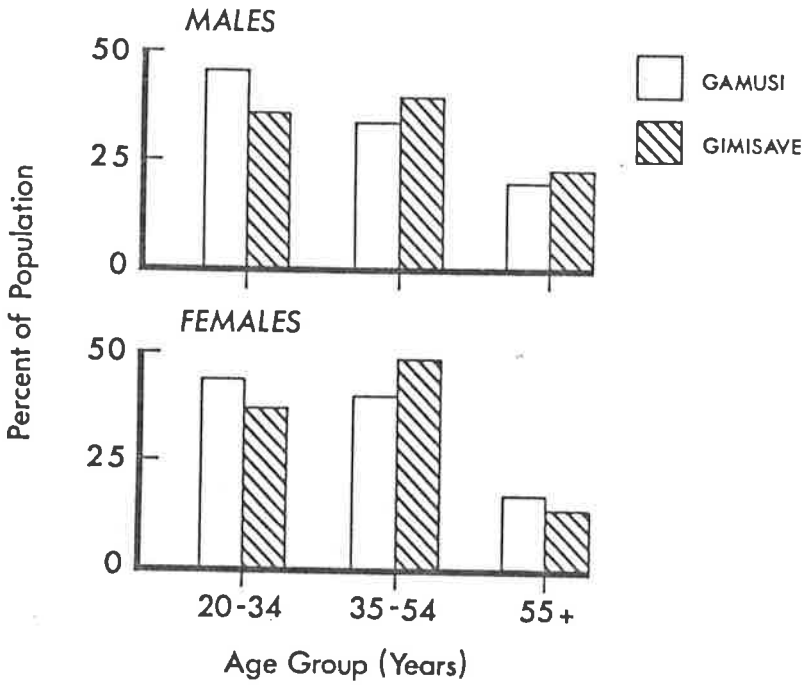

FIGURE 1.2: The age structure of the two village populations. Asaro Valley diabetes survey, Papua New Guinea, 1983

TABLE 1.2: The prevalence of impaired glucose tolerance and diabetes. Asaro Valley diabetes survey, Papua New Guinea, 1983

	No. studied	Prevalence (%)	
		Impaired glucose tolerance	Diabetes
Gamusi			
Males	97	4.1	0.0
Females	91	1.1	0.0
Sexes combined	188	2.7	0.0
Gimisave			
Males	47	2.1	0.0
Females	73	1.4	0.0
Sexes combined	120	1.7	0.0

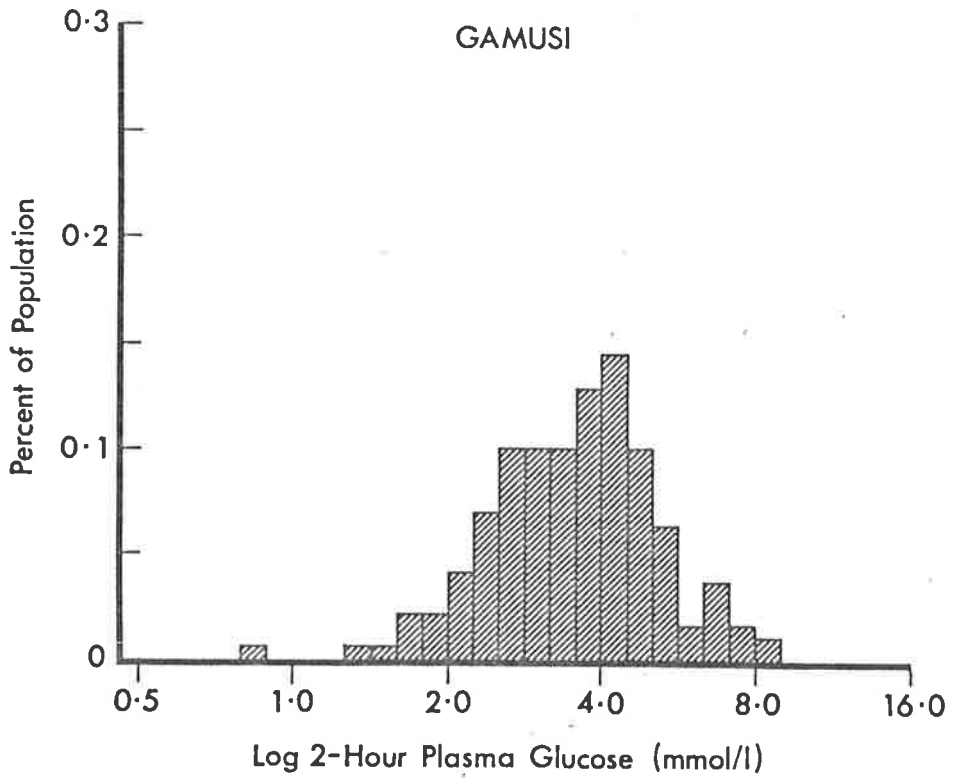

FIGURE 1.3a: Distribution of Log two-hour plasma glucose concentration (mmol/l) in Gamusi. Sexes combined (n = 188). Asaro Valley diabetes survey, 1983

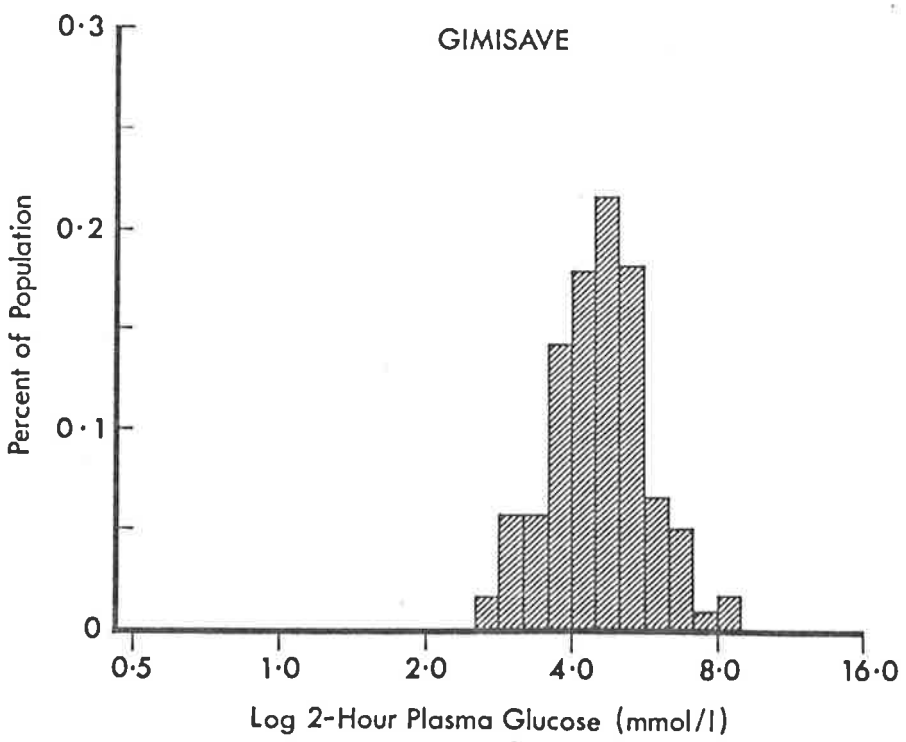

FIGURE 1.3b: Distribution of Log two-hour plasma glucose concentration (mmol/l) in Gimisave. Sexes combined (n = 120). Asaro Valley diabetes survey, 1983

TABLE 1.3: Mean (SEM) for selected variables. Asaro Valley diabetes survey, Papua New Guinea, 1983

	GAMUSI		GIMISAVE	
	M	F	M	F
n	97	91†	47	73
Age (years)	39.9(1.5)	39.4(1.5)	42.9(2.1)	38.8(1.4)
2 h plasma glucose (mmol/l)	3.8(0.2)***	3.8(0.1)***	4.7(0.2)	4.7(0.1)
2 h plasma insulin (μU/ml)	17.6(1.7)	18.3(1.6)	15.0(1.2)	20.4(1.5)
Body mass index (kg/m^2)	22.0(0.2)	21.3(0.3)**	22.2(0.3)	22.3(0.3)
Triceps skinfold thickness (mm)	6.6(0.2)	10.5(0.4)**	7.2(0.3)	12.2(0.5)
Subscapular skinfold thickness (mm)	9.9(0.2)	12.3(0.5)*	10.6(0.4)	14.1(0.6)
Sum of skinfolds (mm)	16.5(0.4)	22.8(0.9)**	17.8(0.6)	26.3(1.0)

* $p < 0.05$)
** $p < 0.01$) for comparison between Gamusi and Gimisave (Student's t-test)
*** $p < 0.001$)

† Anthropometric measurements unavailable for one subject

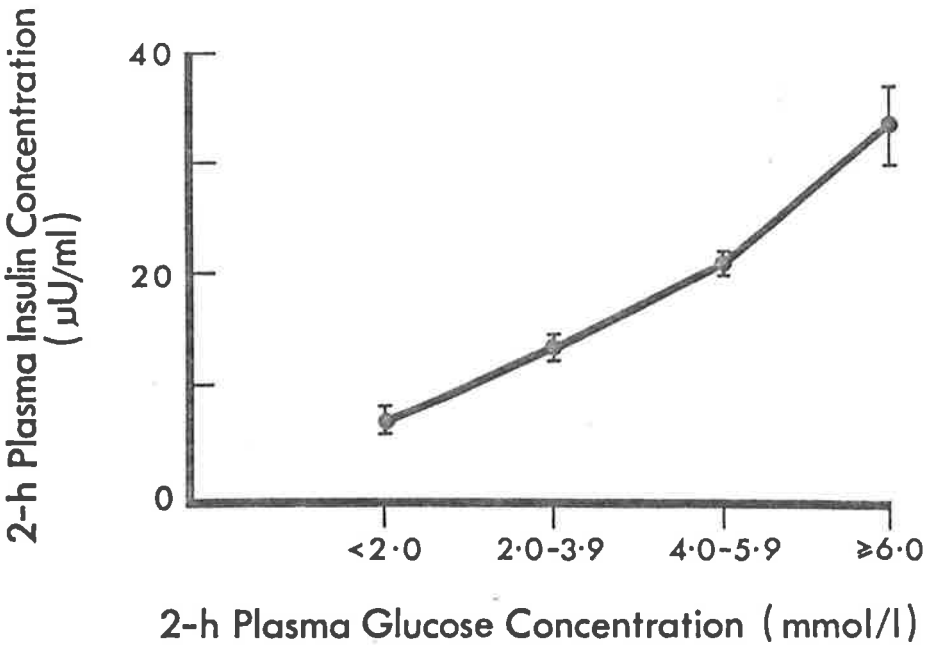

FIGURE 1.4: The relationship between two-hour plasma glucose concentration (mmol/l) and two-hour plasma insulin concentration (μU/ml) in the whole study population (n = 308). Results expressed as mean ± SEM. Asaro Valley diabetes survey, 1983

TABLE 1.4: Coefficients of linear correlation between selected variables. Asaro Valley diabetes survey, Papua New Guinea, 1983

	2 h plasma glucose	Age	2 h plasma insulin	Body mass index	Triceps SFT	Subscapular SFT
MALES						
Age	0.3					
2 h plasma insulin	0.5	0.1				
Body mass index	-0.2	-0.4	0.0			
Triceps SFT	0.1	-0.1	0.2	0.4		
Subscapular SFT	0.0	-0.1	0.0	0.4	0.7	
Sum of skinfolds	0.1	-0.1	0.1	0.4	0.9	0.9
FEMALES						
Age	0.1					
2 h plasma insulin	0.4	-0.1				
Body mass index	0.1	-0.6	0.1			
Triceps SFT	0.1	-0.4	0.1	0.6		
Subscapular SFT	0.1	-0.5	0.1	0.7	0.8	
Sum of skinfolds	0.1	-0.5	0.2	0.7	0.9	1.0

SFT Skinfold thickness

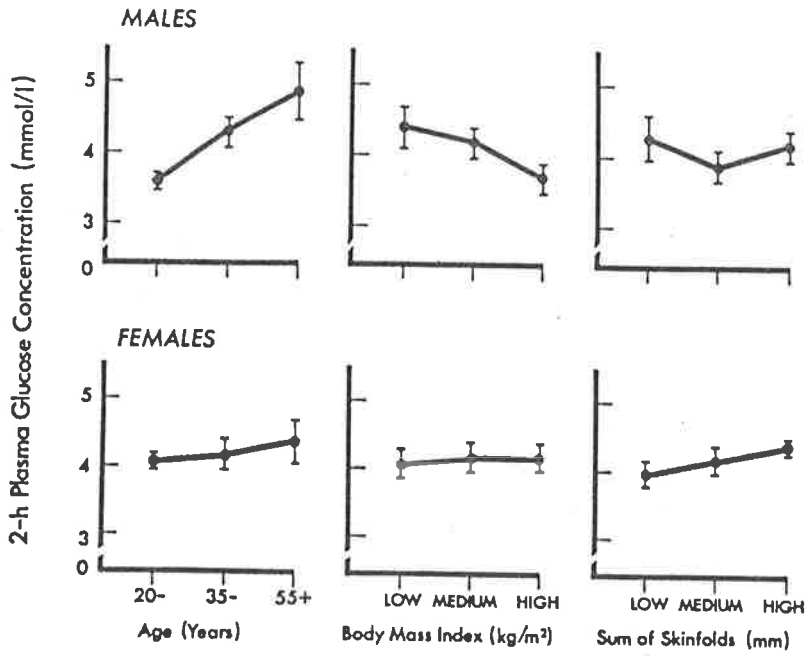

FIGURE 1.5: Two-hour plasma glucose concentration (mmol/l) in age groups and in tertiles of the distribution of body mass index and sum of skinfolds. Results expressed as mean ± SEM. Asaro Valley diabetes survey, 1983

TABLE 1.5: Analysis of variance of two-hour plasma glucose concentration by village of residence, age group and quartiles of body mass index and sum of skinfolds. Asaro Valley diabetes survey , Papua New Guinea, 1983

	Sum of squares	d.f	F	P
MALES (n = 144)				
Main effects:				
Village of residence	15.0	1	7.1	<0.01
Age group	14.5	2	3.4	<0.05
Quartile of body mass index (kg/m^2)	13.9	3	2.2	N.S.
Quartile of sum of skinfolds (mm)	12.0	3	1.9	N.S.
Village x age group interaction	16.8	2	4.0	<0.05
FEMALES (n = 163)†				
Main effects:				
Village of residence	30.2	1	22.9	<0.001
Age group	1.4	2	0.5	N.S.
Quartile of body mass index (kg/m^2)	2.9	3	0.7	N.S.
Quartile of sum of skinfold (mm)	3.4	3	0.9	N.S.

† Anthropometric measurements unavailable for one subject

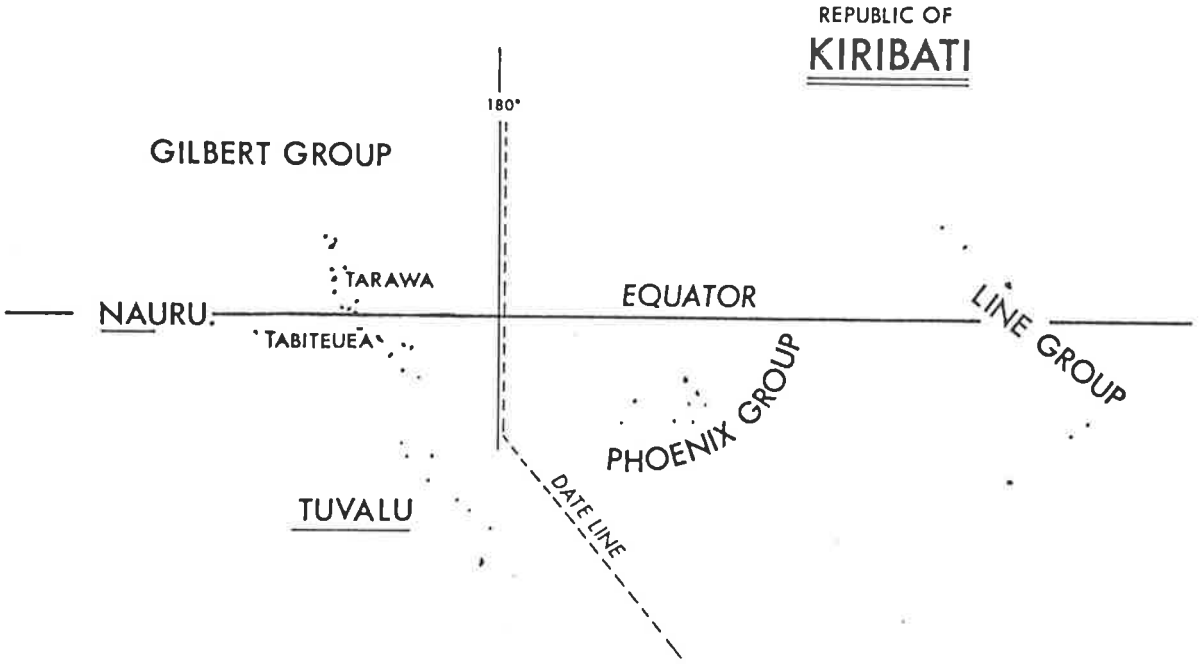

FIGURE 2.1: The Republic of Kiribati and adjacent neighbours

TABLE 2.1: Age and sex distribution of Kiribati survey population and dietary sub-sample Kiribati diabetes survey, 1981

	MALES				FEMALES			
	20-34	35-54	55+	All ages	20-34	35-54	55+	All ages
Rural survey population	176	191	107	474	238	212	114	564
Dietary sub-sample	65	77	40	182	82	89	45	216
Proportion in dietary sub-sample (%)	36.9	40.3	37.4	38.4	34.5	42.0	39.5	38.3
Urban survey population	491	368	60	919	549	349	83	981
Dietary sub-sample	159	128	26	313	198	127	26	351
Proportion in dietary sub-sample (%)	32.4	34.8	43.3	34.1	36.1	36.4	31.3	35.8

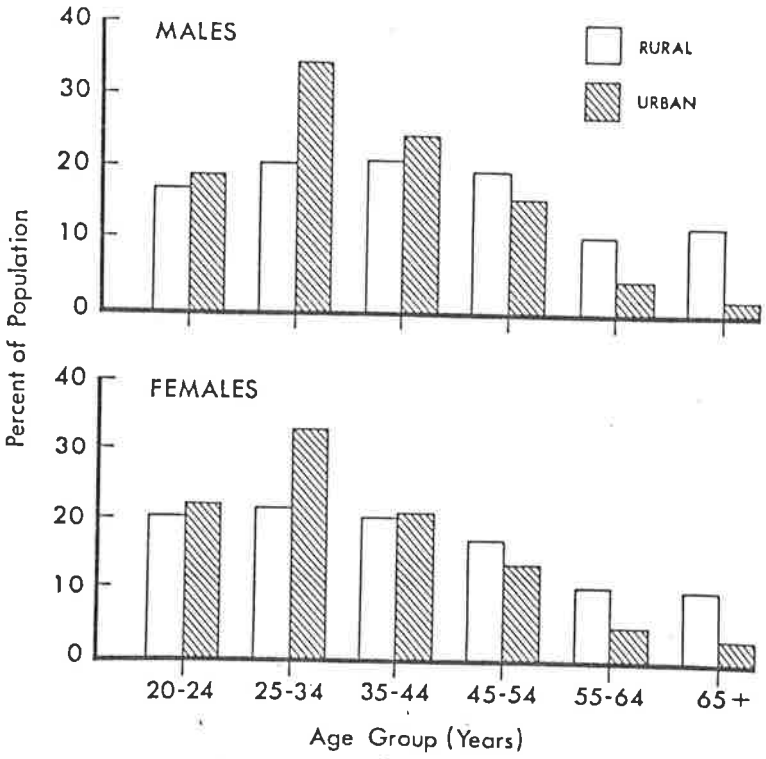

FIGURE 2.2: Age structure of rural and urban population by sex. Kiribati diabetes survey, 1981

TABLE 2.2: Prevalence(%) of impaired glucose tolerance and diabetes mellitus in Kiribati by region, age group, and sex*. Kiribati diabetes survey, 1981

		IMPAIRED GLUCOSE TOLERANCE				DIABETES MELLITUS			
		Rural		Urban		Rural		Urban	
Sex	Age group (years)	No.	%	No.	%	No.	%	No.	%
Males	20-24	79	3.8	168	4.8	79	1.3	168	0.6
	25-34	97	4.1	314	11.1	97	1.0	314	3.5
	35-44	96	14.6	223	17.5	96	3.1	223	8.5
	45-54	93	15.1	143	23.8	93	5.4	143	19.6
	55-64	49	18.4	41	36.6	49	6.1	41	26.8
	65+	57	26.3	18	27.8	57	7.0	18	16.7
	All ages	471	12.5	907	15.0	471	3.6	907	8.1
Females	20-24	114	6.1	217	10.6	114	0.9	217	1.4
	25-34	122	12.3	329	16.1	122	2.5	329	3.6
	35-44	114	14.9	207	16.9	114	3.5	207	8.2
	45-54	98	20.4	139	25.9	98	5.1	139	15.8
	55-64	57	15.8	49	12.2	57	8.8	49	22.4
	65+	55	21.8	32	34.4	55	3.6	32	21.9
	All ages	560	14.3	973	16.9	560	3.6	973	7.4

* Two-hour plasma glucose unknown in 7 rural and 20 urban subjects

TABLE 2.3: Age-standardized prevalence (%)* of impaired glucose tolerance and diabetes mellitus in Kiribati by region. Kiribati diabetes survey, 1981

Sex	Status	Prevalence (%) Rural	Urban	R.R.†	χ^2**	P
MALES						
	Impaired glucose tolerance	10.6	16.1	1.5	13.0	<0.001
	Diabetes mellitus	3.0	9.1	3.0	24.4	<0.001
	Impaired glucose tolerance and diabetes mellitus	13.6	25.2	1.9	28.3	<0.001
FEMALES						
	Impaired glucose tolerance	13.7	17.9	1.3	6.2	<0.05
	Diabetes mellitus	3.3	8.7	2.6	18.6	<0.001
	Impaired glucose tolerance and diabetes mellitus	17.0	26.6	1.6	16.8	<0.001

* By the direct method using the combined rural and urban study populations as the standard

† Relative risk

** Using the Mantel extension of the Mantel-Haenszel procedure on one degree of freedom

TABLE 2.4: Simple correlation coefficients between body mass index, physical activity score and consumption of imported energy (kJ)* in rural and urban males and females. Kiribati diabetes survey, 1981

	Rural males		Rural females	
	Body mass index	Physical activity	Body mass index	Physical activity
Physical activity	-0.02	-	0.13	-
Imported energy consumption	0.24	-0.14	0.11	-0.21
	Urban males		**Urban females**	
	Body mass index	Physical activity	Body mass index	Physical activity
Physical activity	0.06	-	0.06	-
Imported energy consumption	0.05	0.04	0.19	-0.08

* Dietary sub-sample only

TABLE 2.5: Mean body mass index by age group, region and sex. Kiribati diabetes survey, 1981

		AGE GROUP (YEARS)					
		20-24	25-34	35-44	45-54	55-64	65+
Males	Rural	24.5	25.5	16.6	25.5	24.0	23.0
	Urban	26.1	27.7	28.7	27.8	28.1	25.4
	Analysis of variance			SS	DF	F	P
	Region			18.0	1	49.3	<0.001
	Age group			14.4	5	7.9	<0.05
		AGE GROUP (YEARS)					
		20-24	25-34	35-44	45-54	55-64	65+
Females	Rural	24.7	25.5	25.5	24.4	22.7	20.4
	Urban	27.0	29.2	28.6	28.5	27.5	25.1
	Analysis of variance			SS	DF	F	P
	Region			42.9	1	92.4	<0.001
	Age group			28.3	5	12.2	<0.01

TABLE 2.6: Mean physical activity score by age group, region, and sex. Kiribati diabetes survey, 1981

		AGE GROUP (YEARS)					
		20-24	25-34	35-44	45-54	55-64	65+
Males	Rural	3.3	3.1	3.1	3.1	2.9	2.3
	Urban	2.7	2.5	2.5	2.3	2.1	2.1
	Analysis of variance			SS	DF	F	P
	Region			1.08	1	45.0	<0.01
	Age group			0.79	5	6.6	<0.05
		AGE GROUP (YEARS)					
		20-24	25-34	35-44	45-54	55-64	65+
Females	Rural	2.8	3.0	3.1	2.9	2.6	2.3
	Urban	2.3	2.4	2.6	2.4	2.3	2.0
	Analysis of variance			SS	DF	F	P
	Region			0.61	1	81.0	<0.001
	Age group			0.58	5	15.6	<0.01

TABLE 2.7: Median consumption of imported energy (kJ) per caput/day by age group, region, and sex*. Kiribati diabetes survey, 1981

		AGE GROUP (YEARS)					
		20-24	25-34	35-44	45-54	55-64	65+
Males	Rural	3151	2548	1775	3312	3049	2562
	Urban	5915	5505	4549	4530	4195	4223

Analysis of variance	SS	DF	F	P
Region	13062533.3	1	37.2	<0.01
Age group	2409216.6	5	1.4	NS

		AGE GROUP (YEARS)					
		20-24	25-34	35-44	45-54	55-64	65+
Females	Rural	2465	1900	1019	1554	770	1786
	Urban	4044	4238	3548	3877	3277	2649

Analysis of variance	SS	DF	F	P
Region	12279610.1	1	55.3	<0.001
Age group	2480560.4	5	2.2	NS

* Dietary sub-sample only

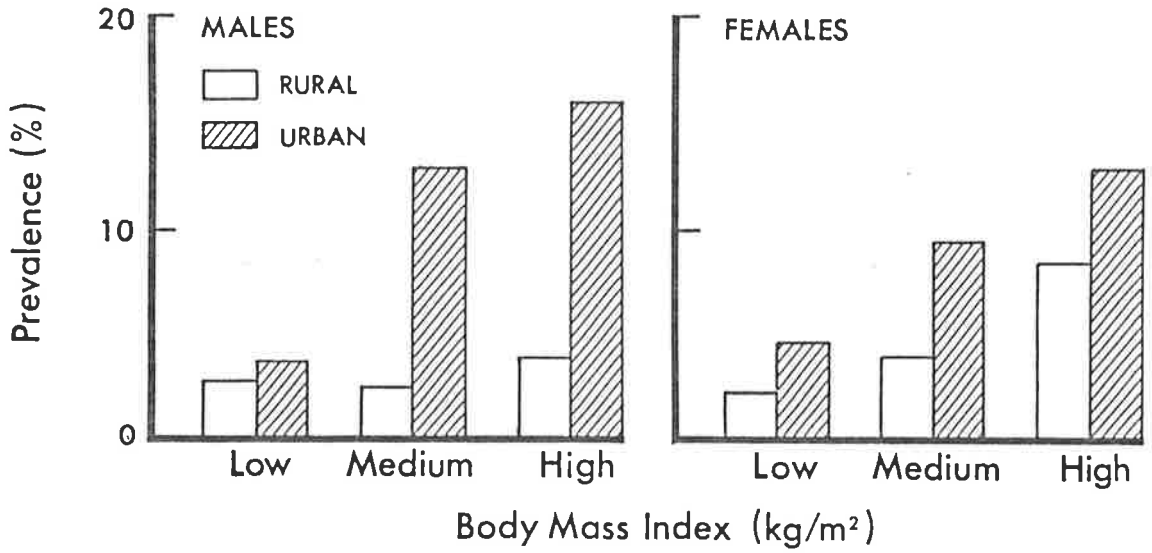

FIGURE 2.3: Age-standardized prevalence (%) of diabetes in rural and urban samples stratified by tertiles of body mass index. Kiribati diabetes survey, 1981

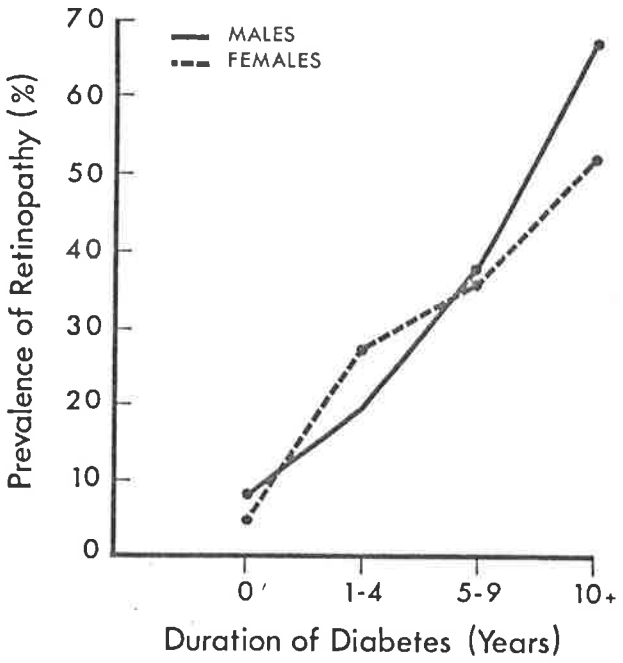

FIGURE 3.1: The relationship between duration of diabetes and prevalence of retinopathy. Nauruan diabetics, 1982

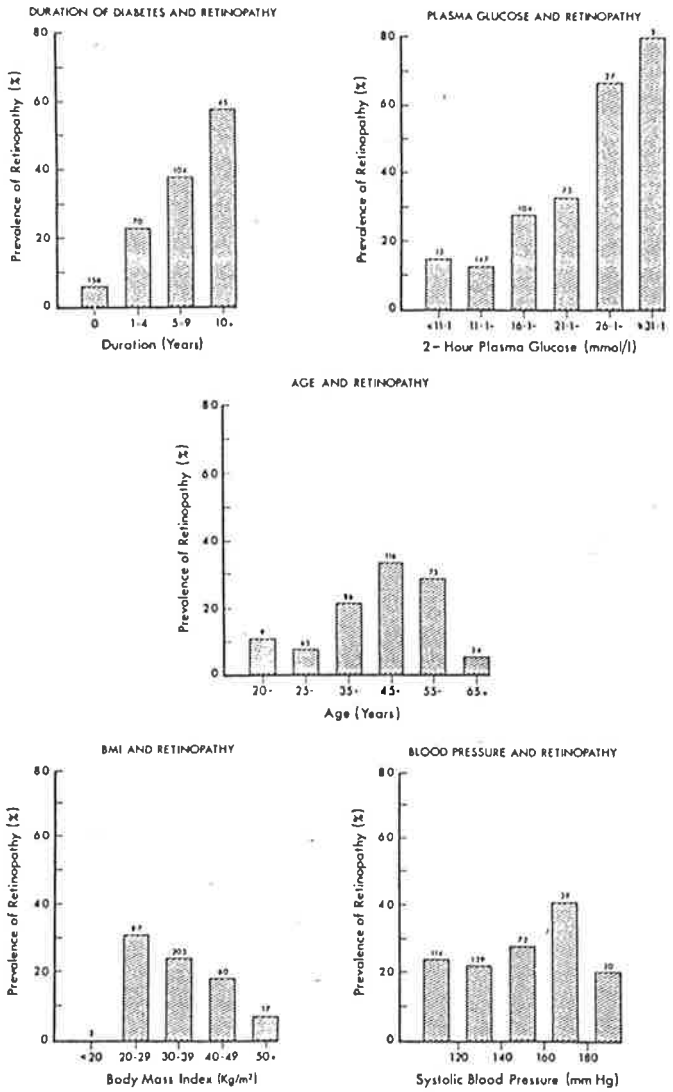

FIGURE 3.2. The relationship between five selected characteristics and the prevalence of retinopathy. Nauruan diabetics, 1982 (sexes combined)

TABLE 3.1: Correlation coefficients between selected characteristics, sexes combined. Nauruan diabetics, 1982

	Age	Two-hour plasma glucose	Body mass index	Duration
Two-hour plasma glucose (mmol/l)	0.01	-	-	-
Body mass index (kg/m^2)	-0.26	-0.20	-	-
Duration (years)	0.16	0.32	-0.17	-
Systolic blood pressure (mmHg)	0.09	-0.11	0.32	-0.08

TABLE 3.2: Mean ± SEM of selected characteristics according to sex and retinopathy status. Nauruan diabetics, 1982

	MALES		FEMALES	
Retinopathy	Present	Absent	Present	Absent
Age (years)	48.5±1.5	47.4±1.2	48.8±1.4	44.6±1.0*
Two-hour plasma glucose (mmol/l)	19.9±0.7	17.0±0.4***	21.2±1.0	17.4±0.4***
Body mass index (kg/m²)	32.8±0.7	33.7±0.6	33.9±1.0	36.7±0.6*
Duration of diabetes (years)	6.9±0.7	2.7±0.3***	8.5±1.0	2.6±0.3***
Systolic blood pressure (mmHg)	136.3±3.4	133.3±2.4	136.2±4.3	134.1±2.0

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; Student's t-test

TABLE 3.3: Coefficients and other characteristics of the full logistic regression models predicting retinopathy status. Each model includes the six age group constants. Nauruan diabetics, 1982

	Males (n=155)	Females (n=188)
Duration (years)	0.45(0.09)†	0.33(0.08)
Two-hour plasma glucose (mmol/l)	0.21(0.07)	0.08(0.04)
Systolic blood pressure (mmHg)	0.02(0.01)	0.01(0.01)
Body mass index (kg/m^2)	0.02(0.05)	0.06(0.04)

Measures of the fit of the full models

	Males (n=155)	Females (n=188)
Deviance	93.9	101.4
Degrees of freedom	145	178
Entropy	0.45	0.46

† Number in parentheses indicates standard error

TABLE 3.4: Comparison of optimal logistic regression models with one, two, three and four variables included. The six age group constants were included in each model. Nauruan diabetics, 1982

Step	Variables in the model	Degrees of freedom	Deviance	χ^2† (d.f.= 1)
MALES (n = 55)				
1	Age	149	155.3	47.9***
2	Age, duration	148	107.4	10.8**
3	Age, duration, two-hour plasma glucose	147	96.6	2.5
4	Age, duration, two-hour plasma glucose, systolic blood pressure	146	94.1	0.2
5	Age, duration two-hour plasma glucose, systolic blood pressure, body mass index	145	93.9	
FEMALES (n = 188)				
1	Age	182	154.1	45.8***
2	Age, duration	181	108.3	4.2*
3	Age, duration, two-hour plasma glucose,	180	104.1	1.4
4	Age, duration, two-hour plasma glucose, body mass index	179	102.7	1.3
5	Age, duration, two-hour plasma glucose, body mass index, systolic blood pressure,	178	101.4	

† The χ^2 value is the observed value for a likelihood ratio test. Each model is compared with the preceding model to test for the significance of the inclusion of the additional predictor variable

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

TABLE 4.1: Distribution of the 266 non-diabetic subjects by age and diabetic status at initial examination. Nauru follow-up study, 1965/6-1982

	Normal		Impaired glucose tolerance	
	No.	% of total	No.	% of total
MALES				
0-19	26	27.1	2	9.1
20-29	38	39.6	7	31.8
30-39	14	14.6	3	13.6
40-49	15	15.6	6	27.3
50-59	3	3.1	2	9.1
60+	0	0.0	2	9.1
All ages	96	100.0	22	100.0
FEMALES				
0-19	42	35.3	2	6.9
20-29	43	36.1	8	27.6
30-39	16	13.5	6	20.7
40-49	11	9.2	10	34.5
50-59	6	5.0	3	10.3
60+	1	0.8	0	0.0
All ages	119	100.0	29	100.0

TABLE 4.2: Comparison of diabetic status of Nauruan non-diabetics in 1975-1976 and follow-up status in 1982

Diabetic status in 1975-1976	Diabetic status in 1982			
	Normal	Impaired glucose tolerance	Diabetic	Total
MALES				
Normal	72	17	7	96
Impaired glucose tolerance	7	9	6	22
FEMALES				
Normal	95	17	7	119
Impaired glucose tolerance	13	9	7	29
SEXES COMBINED				
Normal	167	34	14	215
Impaired glucose tolerance	20	18	13	51

TABLE 4.3: Parameter estimates, standard errors, and standardized parameter estimates for selected baseline variables, derived from the multiple logistic regression model† predicting progression to diabetes (n = 264).†† Nauru follow-up study, 1975/6-1982

Variable	Parameter estimate	Standard error	Standardized parameter estimate§
Age (years)	0.32	0.14	2.3*
Age squared	-4×10^{-3}	-2×10^{-3}	-2.1*
Sex (female)	-0.51	0.46	-1.1
Date of first examination	-0.10	0.45	0.2
Body mass index (kg/m^2)	0.09	0.03	2.5*
Impaired glucose tolerance	1.40	0.47	3.0**

† Log likelihood statistic : 140.3 on 257 degrees of freedom (see results)

†† Two cases deleted due to missing data

* $p < 0.05$

** $p < 0.01$

§ The standardized parameter estimate may be referred to tables of the normal distribution as a test of significance of the parameter in the regression equation

TABLE 4.4: Mean† values of selected baseline variables in subjects not progressing, compared with those progressing to diabetes.†† Nauru follow-up study, 1975/6-1982

Variable	Not progressing to diabetes (n = 37)	Progressing to diabetes (n = 13)
Age (years)	35.9	40.7
2-h plasma glucose (mmol/l)	8.6	9.5**
Fasting plasma glucose(mmol/l)	5.6	6.4**
Body mass index (kg/m²)	30.7	35.3**
Triceps skinfold index (mm)	25.8	31.5
Plasma cholesterol (mmol/l)	5.3	5.3
Plasma triglycerides (mmol/l)	1.3	1.6
Plasma uric acid (mmol/l)	0.4	0.4
Systolic blood pressure (mmHg)	136	131
Urinary creatinine (mmol/l)	0.1	0.1
% cigarette smokers	50.0	46.2
% positive family history of diabetes	51.7	50.0

† Continuous variables standardized for age by analysis of covariance

†† Subjects with impaired glucose tolerance only (n = 50)
one case deleted due to missing data

** $p < 0.01$ (F test)

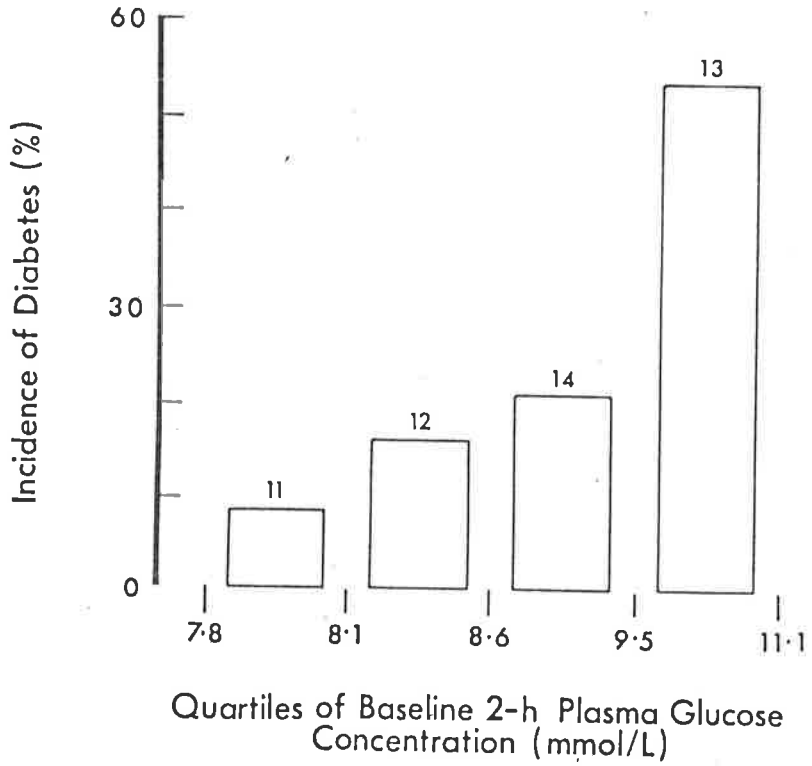

FIGURE 4.1: The incidence of subsequent diabetes during the study period in the four quartiles of baseline two-hour plasma glucose concentration in subjects with impaired glucose tolerance. Nauru follow-up study, 1976/6-1982

TABLE 4.5: Parameter estimates, standard errors, and standardized parameter estimates for selected variables derived from the multiple logistic regression model† predicting progression to diabetes.†† Nauru follow-up study, 1975/6-1982

Variable	Parameter estimate	Standard errror	Standardized parameter estimate§
Age (years)	0.15	0.07	2.2*
Sex (female)	-1.33	1.58	-0.8
Date of first examination	0.46	1.43	0.3
2-h Plasma glucose (mmol/l)	2.52	1.06	2.4*
Body mass index(kg/m^2)	0.22	0.11	1.9
Plasma cholesterol(mmol/l)	-1.31	1.19	-1.1
Plasma triglycerides(mmol/l)	2.68	1.64	1.6
Plasma uric acid(mmol/l)	11.26	11.05	1.0
Urinary creatinine(mmol/l)	-36.23	36.59	-1.0
Systolic blood pressure(mmHg)	-0.11	0.06	-2.0*
Cigarette smoking	-3.00	1.62	-1.9

* $p < 0.05$

† Log likelihood statistic : 29.4 on 38 degrees of freedom (see results)

†† Subjects with impaired glucose tolerance only (n = 50, one case deleted due to missing data)

§ The standardized parameter estimate may be referred to tables of the normal distribution as a test of significance of the parameter in the regression equation

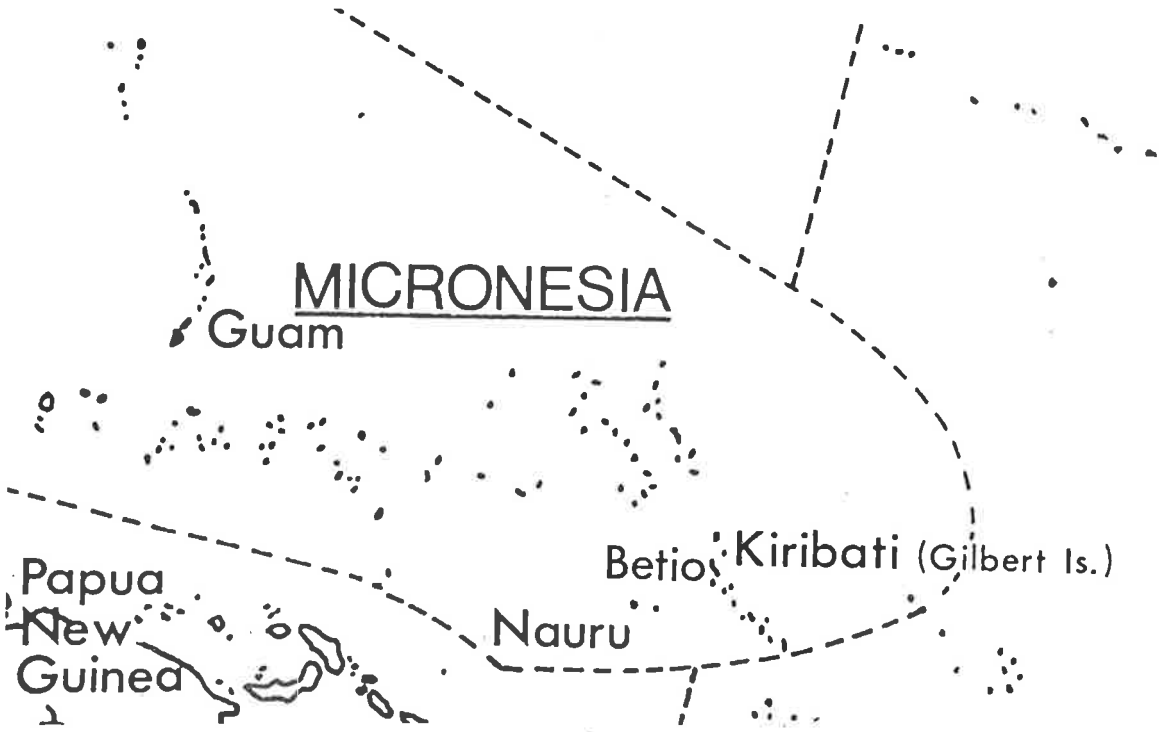

FIGURE 5.1: Map of Micronesia showing the positions of Betio, in the Republic of Kiribati, and of Nauru

TABLE 5.1: The prevalence of diabetes in the full Betio and Nauru samples (n = 2306). Kiribati diabetes survey, 1981; Nauru diabetes survey, 1982

	No. examined	Crude prevalence (%)	Age-standardized† prevalence (%)	Relative risk for Nauruans
MALES				
Betio	435	9.9	10.7	2.6***
Nauru	561	25.7	28.9	
FEMALES				
Betio	497	9.3	11.3	2.6***
Nauru	813	23.9	28.3	

† To the census population of Western Samoa, 1976 by the direct method

*** $p < 0.001$ [using the Mantel extension of the Mantel-Haenszel procedure (Mantel, 1963)]

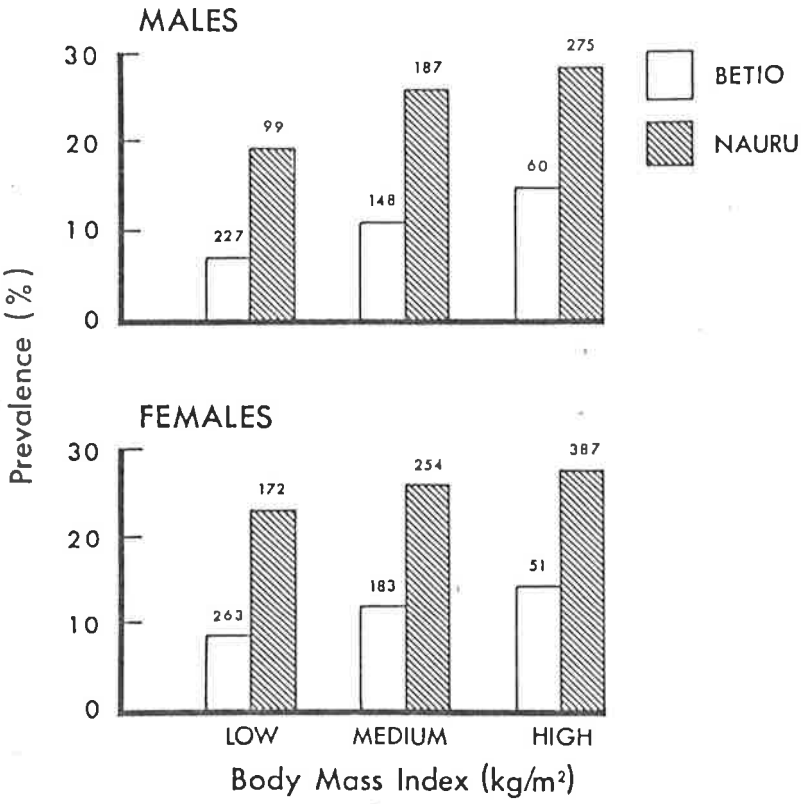

FIGURE 5.2: Age-standardized* prevalence of diabetes (%) in inactive urbanized subjects in Betio and Nauru, stratified by tertiles of the combined distribution of body mass index for each sex. Kiribati diabetes survey, 1981; Nauru diabetes survey, 1982

* to the survey population in Kiribati by the indirect method

TABLE 5.2: Mean(±S.E.M.) age and body mass index in the full Betio and Nauru samples (n = 2306). Kiribati diabetes survey, 1981; Nauru diabetes survey, 1982

	MALES		FEMALES	
	Betio (n = 435)	Nauru (n = 561)	Betio (n = 497)	Nauru (n = 813)
Age (years)	37.8(0.6)	37.5(0.6)	35.8(0.6)	35.5(0.5)
Body mass index (kg/m^2)	27.9(0.2)	33.1(0.3)	28.1(0.2)	34.8(0.3)

TABLE 5.3: Results of the multiple logistic regression models predicting diabetic status in the full Betio and Nauru samples. Kiribati diabetes survey, 1981; Nauru diabetes survey, 1982

Step	Variables in the model	d.f.	Log-likelihood statistic	χ^2†(d.f.)
MALES (n = 996)				
1	Null model	995	962	191^{***} (2)
2	Age, age²	993	771	35^{***} (1)
3	Age, age², body mass index	992	736	31^{***} (1)
4	Age, age², body mass index, ethnicity	991	705	
FEMALES (n = 1310)				
1	Null model	1039	1248	200^{***} (2)
2	Age, age²	1037	1048	20^{***} (1)
3	Age, age², body mass index	1036	1028	36^{***} (1)
4	Age, age², body mass index, ethnicity	1035	992	

† The χ^2 value is the observed value for the likelihood ratio test

Each model is compared with the preceding model to test for the significance of the inclusion of the additional predictor variable

*** $p < 0.001$

TABLE 5.4: Parameter estimates, standard errors and standardized parameter estimates† from the final multiple logistic regression models predicting diabetic status in the full Betio and Nauru samples. Kiribati diabetes survey, 1981; Nauru diabetes survey, 1982

Parameter (n = 996)	Males (n = 996)			Females (n = 1310)		
	Parameter estimate	Standard error	Standardized parameter estimate	Parameter estimate	Standard error	Standardized parameter estimate
Age (years)	0.35	0.05	7.5^{***}	0.26	0.04	6.7^{***}
Age squared	$-3x10^{-3}$	$4x10^{-4}$	-5.9^{***}	$-2x10^{-3}$	$4x10^{-4}$	4.9^{***}
Ethnicity (Nauruan)	1.19	0.22	5.4^{***}	1.18	0.20	5.8^{***}
Body mass index (kg/m^2)	0.06	0.02	3.2^{**}	0.02	0.01	1.4

** $p < 0.01$
*** $p < 0.001$
† The standardized parameter estimate may be referred to tables of the normal distribution as a test of significance of the parameter in the regression equation

TABLE 5.5: Mean (±SEM) age, body mass index and daily intake of selected dietary variables in Betio and Nauru dietary sub-samples (n = 694). Kiribati diabetes survey, 1981; Nauru diabetes survey, 1982

	MALES		FEMALES	
	Betio (n = 154)	Nauru (n = 176)	Betio (n = 188)	Nauru (n = 176)
Age (years)	39.7(1.1)	37.6 (1.0)	35.3(1.0)	36.8 (1.1)
Body mass index (kg/m²)	27.5(0.4)	33.1 (0.5)	28.2(0.4)	35.5 (0.6)
Daily nutrient intakes:				
Total energy (mJ)	7.6(0.2)	13.5 (0.5)	6.5(0.2)	10.6 (0.4)
Carbohydrate (g)	249.4(7.7)	349.2(11.2)	214.7(5.7)	305.9(12.0)
Fat (g)	49.7(2.4)	105.3 (6.6)	50.0(2.4)	90.5 (4.9)
Dietary fibre (g)	9.5(0.6)	8.3 (0.5)	8.6(0.5)	7.4 (0.4)

TABLE 5.6: Correlation coefficients between continuous variables in Betio and Nauru dietary sub-samples (n = 694). Kiribati diabetes survey, 1981; Nauru diabetes survey, 1982

		Age	Body mass index	Total energy	Carbohydrate	Fat
MALES (n = 330)	Body mass index	0.00				
	Total energy	-0.17	0.35			
	Carbohydrate	-0.22	0.25	0.74		
	Fat	-0.12	0.27	0.73	0.34	
	Dietary fibre	-0.03	0.02	0.23	0.32	0.22
FEMALES (n = 364)	Body mass index	0.03				
	Total energy	-0.14	0.39			
	Carbohydrate	-0.17	0.34	0.88		
	Fat	-0.08	0.29	0.84	0.59	
	Dietary fibre	-0.04	-0.01	0.32	0.31	0.32

TABLE 5.7: Results of the forward selection procedure using the multiple logistic regression model to predict diabetic status in the Betio and Nauru dietary sub-samples. At each step, the χ^2 value associated with the introduction of each variable is shown.† For each sex, age is controlled for at Step 2. Kiribati diabetes survey, 1981; Nauru diabetes survey, 1982

Step	Variables in the model	d.f.	Log-likelihood	χ^2 value associated with the addition of each variable to the model					
				Ethnicity	BMI	ENER	CHO	FAT	DFIB
Males (n = 330)									
1	Null model	329	324.6						
2	Age, age²	327	259.7	28.8***	8.1**	2.8	3.5	0.4	0.4
3	Age, age², ethnicity	326	230.9	-	0.6	1.0	0.0	1.5	0.0
4	Age, age², BMI	326	251.6	21.3***	-	0.8	1.7	0.0	0.5
Females (n = 364)									
1	Null model	363	353.5						
2	Age, age²	361	290.9	15.8***	12.4***	2.9	0.4	5.4*	0.0
3	Age, age², ethnicity	360	275.1	-	2.7	0.0	0.7	1.0	0.0
4	Age, age², BMI	360	278.5	6.1*	-	0.0	0.5	1.6	0.0

BMI Body mass index (kg/m²). ENER total energy consumption (mJ). CHO total carbohydrate (g). FAT total fat (g). DFIB Dietary fibre (g).

† The χ^2 value is the observed value for the likelihood ratio test comparing models with and without the variable included, whilst retaining the variables shown to be entered at the particular step

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

TABLE 6.1: Baseline characteristics of the study populations. Melanesians and Indians, Fiji, 1980; Micronesians, Kiribati, 1981

	Melanesians		Indians		Micronesians	
	Rural	Urban	Rural	Urban	Rural	Urban
MALES						
No. examined	239	396	212	381	469	906
Mean age (years)	40.0(0.9)†	40.0(0.7)	37.8(0.9)	38.9(0.7)	42.1(0.7)	35.7(0.4)**
Mean body mass index (kg/m^2)	25.6(0.2)	26.1(0.2)	21.6(0.3)	23.0(0.2)**	25.1(0.2)	27.7(0.1)**
Per cent of population overweight§	25	36**	8	13	25	55**
Per cent of population physically inactive	9	91**	17	73**	25	48**
FEMALES						
No. examined	236	460	239	454	556	971
Mean age (years)	40.5(1.0)	39.0(1.8)	38.4(0.9)	37.4(0.6)	40.6(0.7)	35.2(0.4)**
Mean body mass index (kg/m^2)	26.4(0.3)	28.2(0.3)**	23.3(0.3)	24.1(0.3)*	24.4(0.2)	28.3(0.2)**
Per cent of population overweight§	56	68**	34	40	40	72**
Per cent of population physically inactive	47	94**	76	97**	19	51**

* $p < 0.05$; ** $p < 0.01$ for rural-urban difference within populations
† numbers in parentheses indicate standard error
§ body mass index ≥ 27 for males or ≥ 25 for females

TABLE 6.2: The prevalence of diabetes in rural and urban Melanesians and Indians in Fiji, 1980 and Micronesians in Kiribati, 1981

	Number examined	Crude prevalence (%)	Relative risk†	χ^2MH	p
MALES					
Melanesians					
Rural	239	1.7	3.0	3.04	N.S.
Urban	396	4.8			
Indians					
Rural	212	12.7	1.2	0.19	N.S
Urban	381	14.2			
Micronesians					
Rural	469	3.6	3.5	19.28	<0.001
Urban	906	8.1			
FEMALES					
Melanesians					
Rural	236	1.7	6.6	12.34	<0.001
Urban	460	8.0			
Indians					
Rural	239	13.0	1.0	0.00	N.S
Urban	454	12.6			
Micronesians					
Rural	556	3.6	2.8	15.87	<0.001
Urban	971	7.3			

† Calculated by the Mantel extension of the Mantel-Haenszel procedure (Mantel, 1963) after stratifying the populations by six age groups

TABLE 6.3: The prevalence of diabetes in tertiles of the distribution of body mass index. Melanesians and Indians, Fiji, 1980; Micronesians, Kiribati, 1981

	Number examined	Crude prevalence (%)	Relative risk†	χ^2MH	p
MALES					
Melanesians					
Low body mass index	210	3.3			
			1.2	0.00	N.S
Medium body mass index	208	3.4			
			0.9	0.01	N.S
High body mass index	217	4.1			
Indians					
Low body mass index	197	9.1			
			1.1	0.01	N.S
Medium body mass index	196	11.7			
			1.6	1.38	N.S
High body mass index	200	20.0			
Micronesians					
Low body mass index	448	3.3			
			2.5	6.48	<0.01
Medium body mass index	462	6.5			
			3.6	15.10	<0.001
High body mass index	465	9.7			
FEMALES					
Melanesians					
Low body mass index	230	1.7			
			3.8	4.72	<0.05
Medium body mass index	232	6.9			
			5.6	7.48	<0.01
High body mass index	234	9.0			
Indians					
Low body mass index	222	5.4			
			1.4	0.39	N.S.
Medium body mass index	240	9.2			
			3.0	8.74	<0.01
High body mass index	231	23.4			
Micronesians					
Low body mass index	503	3.8			
			1.9	3.35	N.S.
Medium body mass index	509	5.1			
			3.8	18.2	<0.001
High body mass index	515	8.9			

† Calculated by the Mantel extension of the Mantel-Haenszel procedure (Mantel, 1963) after stratifying the populations by six age groups. Prevalence in medium and high tertiles is compared with prevalence in the low tertile (1 df)

TABLE 6.4: The prevalence of diabetes in active and inactive Melanesians and Indians in Fiji, 1980 and Micronesians in Kiribati, 1981

	Number examined	Crude prevalence (%)	Relative risk†	χ^2MH	p
MALES					
Melanesians					
Active	421	1.9	2.7	3.98	<0.05
Inactive	214	7.0			
Indians					
Active	280	9.3	2.0	5.37	<0.05
Inactive	313	17.6			
Micronesians					
Active	823	5.0	1.4	1.78	N.S.
Inactive	552	8.9			
FEMALES					
Melanesians					
Active	161	3.1	2.4	2.84	N.S.
Inactive	535	6.7			
Indians					
Active	72	11.1	0.9	0.00	N.S.
Inactive	621	12.9			
Micronesians					
Active	924	4.0	2.4	13.79	<0.001
Inactive	603	9.0			

† Calculated by the Mantel extension of the Mantel-Haenszel procedure (Mantel, 1963) after stratifying the populations by six age groups

TABLE 6.5: Correlation coefficients between selected variables. Melanesians and Indians, Fiji, 1980; Micronesians, Kiribati, 1981

	Melanesians			Indians			Micronesians		
	Age	2h PG	BMI	Age	2h PG	BMI	Age	2h PG	BMI
MALES									
2h PG	0.27*	-	-	0.35*	-	-	0.25*	-	-
BMI	0.17*	0.13*	-	0.20*	0.14*	-	-0.06*	0.15*	-
Physical activity	-0.14*	-0.12*	0.00	-0.12*	-0.04	-0.12*	-0.12*	-0.13*	-0.14*
FEMALES									
2h PG	0.34*	-	-	0.36*	-	-	0.20*	-	-
BMI	0.11*	0.14*	-	0.27*	0.28*	-	-0.16*	0.13*	-
Physical activity	0.03	-0.04	-0.04	-0.03	0.03	0.04	-0.01	-0.07	-0.06

* $p < 0.001$
BMI Body mass index; 2h PG Two-hour plasma glucose

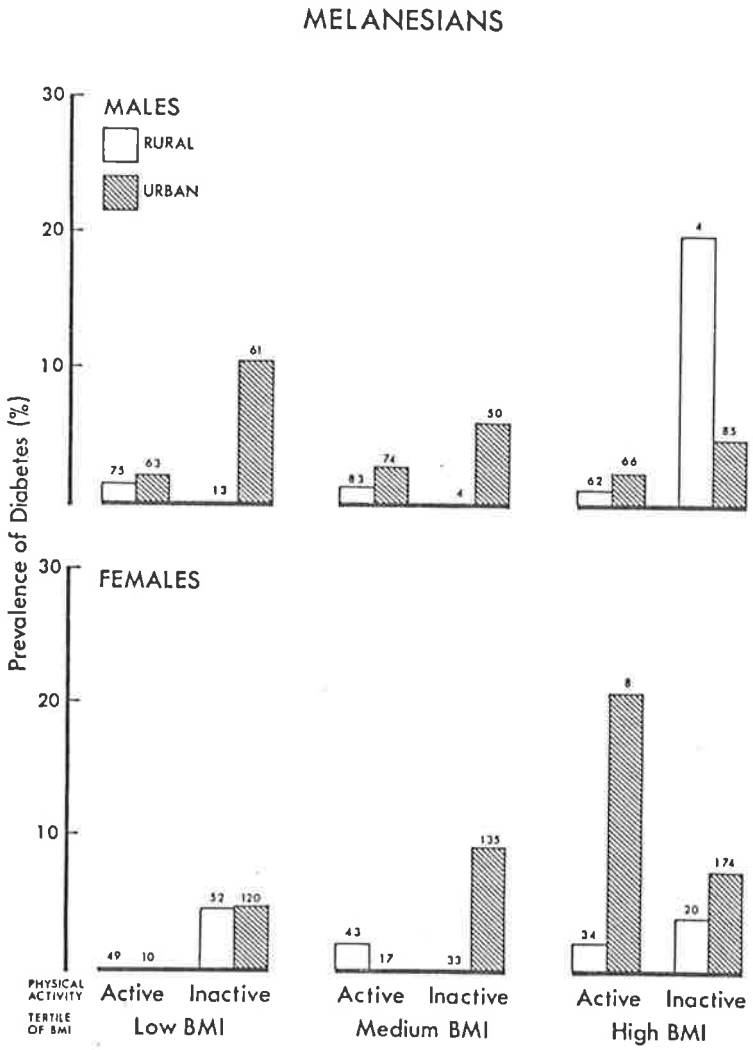

FIGURE 6.1: Prevalence of diabetes (%) stratified by tertiles of body mass index distribution, level of physical activity and urbanization. Melanesians, Fiji, 1980

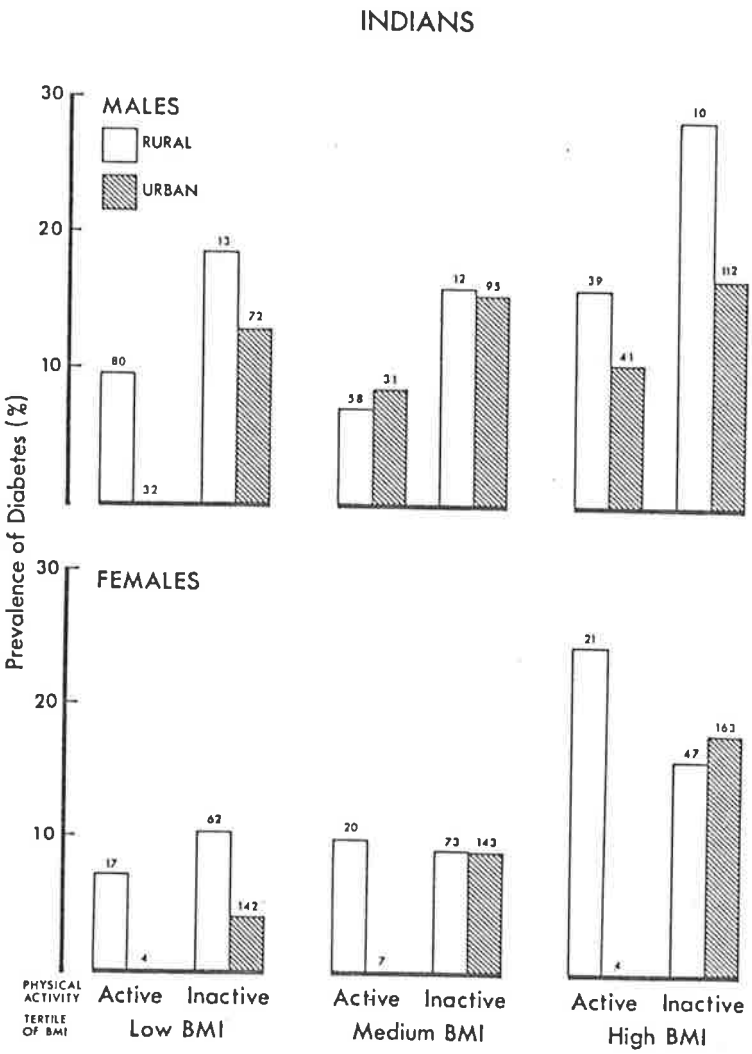

FIGURE 6.2: Prevalence of diabetes (%) stratified by tertiles of body mass index distribution, level of physical activity and urbanization. Indians, Fiji, 1980

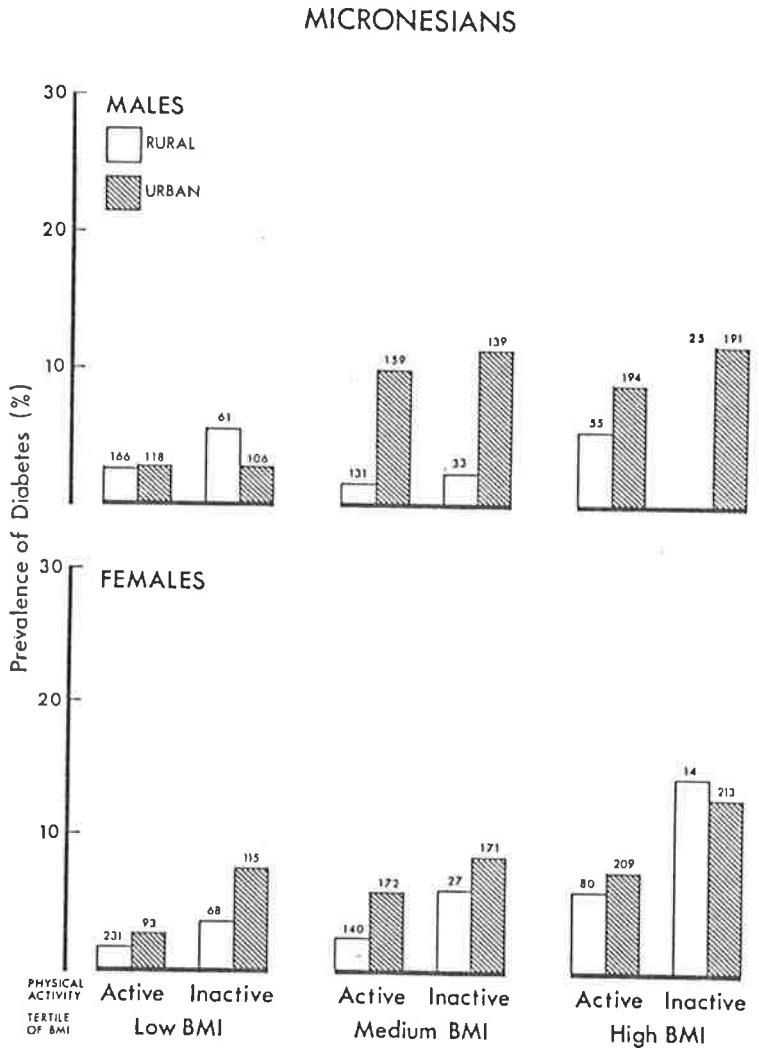

FIGURE 6.3: Prevalence of diabetes (%) stratified by tertiles of body mass index distribution, level of physical activity and urbanization. Micronesians, Kiribati, 1981

TABLE 6.6: Results of the forward selection logistic regression analyses. At each step, the χ^2 value associated with the addition of each variable is shown†. Melanesians and Indians, Fiji, 1980; Micronesians, Kiribati, 1981

Step	Variables in the model	Log likelihood statistic	df	χ^2 value associated with the addition of each factor to the model (1 df) BMI	PA	URB	Interaction
MELANESIAN MALES							
1	Null model	14.6	11	0.0	8.4**	4.1*	-
2	PA	6.2	10	0.0	-	0.8	-
3	PA, URB	5.4	9	0.1	-	-	-
MELANESIAN FEMALES							
1	Null model	21.3	11	3.2	4.2*	8.5**	-
2	URB	12.8	10	1.7	0.5	-	-
3	URB, BMI	11.1	9	-	0.5	-	-
4	URB, BMI, PA	10.6	8	-	-	-	4.2* (BMIxPA)
INDIAN MALES							
1	Null model	16.9	11	3.5	6.8**	0.2	-
2	PA	10.2	10	2.4	-	1.4	-
3	PA, BMI	7.8	9	-	-	2.0	-
INDIAN FEMALES							
1	Null model	25.3	11	18.9***	0.0	0.4	-
2	BMI	6.4	10	-	0.0	0.8	-
3	BMI, URB	5.6	9	-	0.2	-	-
MICRONESIAN MALES							
1	Null model	41.8	11	15.3***	4.2*	19.6***	-
2	URB	22.2	10	8.0**	1.3	-	-
3	URB, BMI	14.2	9	-	1.2	-	-
MICRONESIAN FEMALES							
1	Null model	40.0	11	18.7***	16.2***	18.5***	-
2	BMI	21.3	10	-	8.0**	9.4**	-
3	BMI, URB	11.9	9	-	8.9**	-	-

BMI body mass index (kg/m^2); PA physical activity; URB urbanization
*$p < 0.05$; ** $p < 0.01$; *** $p < 0.001$
The χ^2 value is the observed value for the likelihood ratio test comparing models with and without the variable included, whilst retaining the variables shown to be entered at the particular step

TABLE 6.7: Estimates of relative risk of diabetes associated with selected factors derived from multiple logistic regression equations (standardized for age). Melanesians and Indians, Fiji, 1980; Micronesians, Kiribati, 1981

Risk factor	Melanesian Males	Melanesian Females	Indian Males	Indian Females	Micronesian Males	Micronesian Females
Medium tertile of body mass index§	0.8	1.6	1.3	1.6	2.5 (1.3,4.7)†	1.5
High tertile of body mass index§	0.9	1.8	1.7	3.7 (1.9,7.2)	2.6 (1.4,5.0)	2.5 (1.4,4.5)
Physical inactivity	2.9 (1.1,7.7)	1.5	2.3 (1.3,4.2)	1.2	1.3	1.9 (1.2,3.0)
Urbanization	1.7	2.6	0.6	0.8	2.6 (1.4,4.8)	1.8 (1.0,3.2)
χ^2 (7 df)	6.8	9.5	3.7	3.3	9.0	2.9

† Numbers in parentheses indicate 95% confidence interval of risk ratios significantly greater than 1.0

§ The comparison being with the lowest tertile of body mass index

TABLE 7.1: Age-standardized* prevalence (subjects 20 years and over) of Type 2 diabetes in Pacific populations surveyed by Royal Southern Memorial Hospital Epidemiology Unit, Melbourne, (1975-1980)

Country	Ethnic group	Prevalence † (%)
Nauru	Micronesian	30.3
Tuvalu	Polynesian	3.9
Western Samoa	Polynesian (rural)	2.7
	(urban)	7.0
New Caledonia (mainland)	Melanesian (rural)	1.5
New Caledonia (Loyalty Islands)	Melanesian	2.0
	Polynesian - Melanesian (mixed)	5.8
Fiji	Melanesian (rural)	1.8
	(urban)	6.9
	Indian (rural)	13.3
	(urban)	14.8
Wallis Islands	Polynesian	2.9

* Standardized to the 1976 census of Western Samoa
† WHO Criteria (1980) for diabetes mellitus

(Taken from Zimmet, 1982)

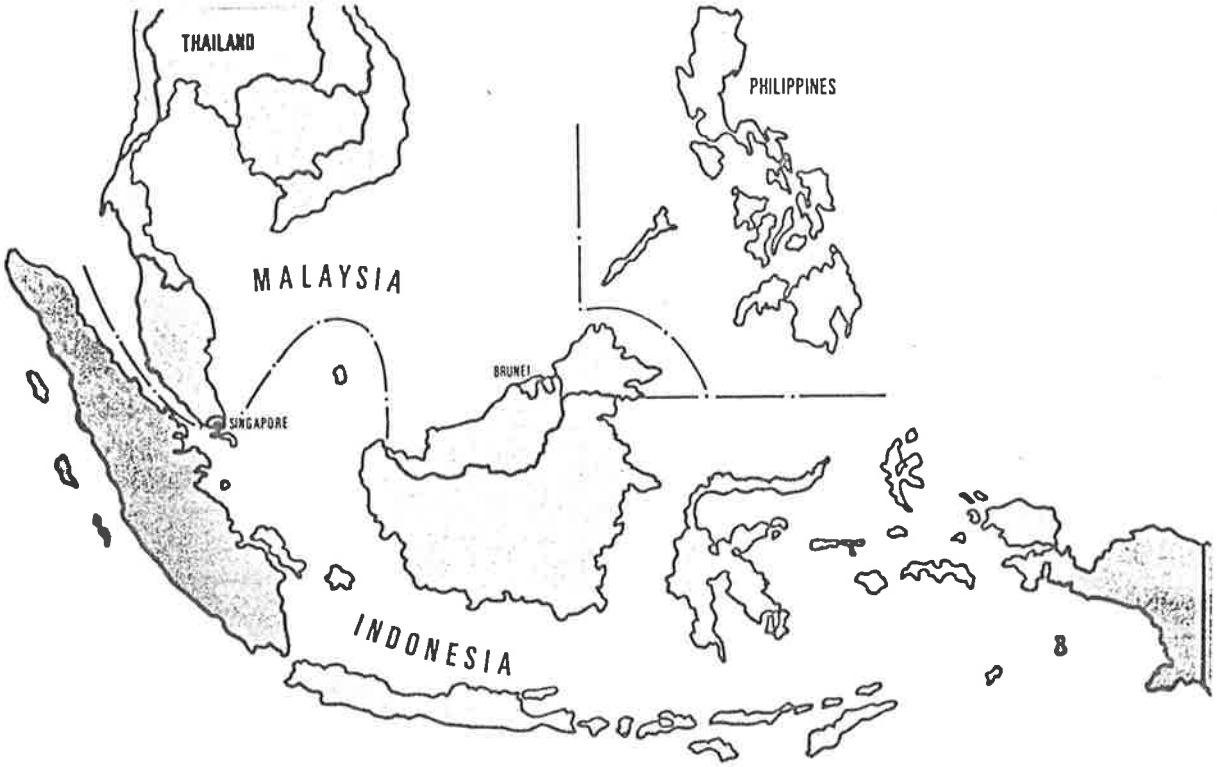

FIGURE A.1: Map of the ASEAN region

TABLE A.1: Some published population-based studies of the prevalence of diabetes in ASEAN countries

Investigator	Date of published source	Country	Region	Ethnic group	Number studied	Age	Prevalence (%)	Diagnostic criteria
West & Kalbfleisch	1966	Malaysia	Urban & rural	Malay	281	Mostly >35	1.8	>150 (1g/kg)
"	"	"	"	Chinese	127	"	4.7	"
"	"	"	"	Indian	144	"	4.2	"
Fernando	1965	Philippines	Urban	Filipino	3638	'adult'	8.0	?
Germau & Villanueva	1966	"	Rural	"	?	?	9.7	? (100g)
Cheah et al.	1974	Singapore	Urban	Malay	288	30-66	1.4	>140 (50g)
"	"	"	"	Chinese	627	"	1.0	"
"	"	"	"	Indian	220	"	6.4	"
"	1978	"	"	Malay	2268	15+	2.4	"
"	"	"	"	Chinese	12812	"	1.6	"
"	"	"	"	Indian	1169	"	6.1	"
Djokomoeljanto et al.	1976	Indonesia	"	Mostly Indonesian	1571	14+	1.5	"
"	1982	"	Semi-urban	"	2822	25+	2.3	? (75g)
Waspadji et al.	1982	"	Urban	"	2749	15+	1.6	WHO criteria (1980)

Prevalence estimates (%): Chinese 1.0-4.7; Malay 1.4-2.4; Indonesian 1.5-2.3; Indian 4.2-6.4; Filipino 8.0-9.7

TABLE A.2: Some published reports of complications of diabetes in ASEAN countries

Investigator	Date of published source	Country	Ethnic group	No. studied	Prevalence (%) in diabetics							
					RETINOPATHY	NEPHROPATHY	CHD	HYPERTENSION	PVD	GANGRENE	NEUROPATHY	TB
Sujono, Sukaton†	1971	Indonesia	Mostly Indonesian	407	8	19	8	22	6	6	56	17
Fernando†	1976	Philippines	Filipino	Review of several studies	8-40	5-31	5-57	15	2	-	15-49	24
Sukono et al.†	1976	Indonesia	Indonesian	1734	16	-	6	22		1	41	16
Jones et al.†	1978	Malaysia	Mixed	132	-	-	20	-	-	8	-	-
Cheah et al.*	1978	Singapore	Mixed	133	9	10	6	27	-	-	3	-

† Study of hospital patients; * population-based data

TABLE A.3: Approximate population size and estimated number of diabetics by country. ASEAN Region

Country	Population	Estimated prevalence of diabetes (%)	Estimated number of diabetics
Indonesia	147,000,000	2	2,940,000
Malaysia	15,000,000	3	450,000
Philippines	45,000,000	4.5	2,025,000
Singapore	2,500,000	2	50,000
Thailand	47,000,000	3.5	1,645,000
Total	256,500,000	2.8	7,110,000

TABLE A.4: Estimated number of subjects with complications of diabetes*. ASEAN region

Country	Retinopathy	Nephropathy	CHD	Hypertension
Indonesia	264,600	294,000	176,400	793,800
Malaysia	40,500	45,000	27,000	121,500
Philippines	182,250	202,500	121,500	546,750
Singapore	4,500	5,000	3,000	13,500
Thailand	148,050	164,500	98,700	444,150
Total	639,900	711,000	426,600	1,919,700

* According to population-based data (Cheah et al. 1978)