Obesity in Pacific populations

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Abstract

Since World War II the rate of modernization in Pacific populations has increased dramatically, bringing changes in lifestyle that have precipitated an epidemic of obesity and increases in the prevalence and incidence of associated non-communicable diseases (NCD), particularly non-insulin-dependent diabetes mellitus (NIDDM).

Studies of Pacific populations conducted over the last 20 years, have shown an increased prevalence of obesity over time, and that obesity has a higher prevalence in urban as opposed to rural areas. The replacement of local food staples with imported processed foods and the reduction in physical activity associated with increasing mechanization and the cash economy are implicated in this trend.

Obesity is an important risk factor for NIDDM and is associated with increased levels of cardiovascular risk factors. Although the level of cardiovascular disease (CVD) is still relatively low in some Pacific countries, further increases are expected. There is little evidence of a direct association between obesity and mortality among Pacific populations, but the association of obesity with NIDDM and other CVD risk factors, which are clearly associated with increased mortality suggests that avoidance of obesity would be beneficial in relation to both morbidity and mortality.

The challenge for Pacific nations is to find effective means of reducing and preventing obesity, combining the beneficial aspects of traditional and modern ways.

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Introduction

Obesity is not new among Pacific populations and has long been regarded as a symbol of high social status and prosperity in the region[1,2]. However, since World War II, obesity has reached epidemic proportions in some communities as lifestyles become increasingly modernized[3]. The increased prevalence of obesity is believed to have contributed to the rise in NCD, especially NIDDM[4-6]. Data collected over the past 20 years during cross-sectional and longitudinal studies of obesity and NCD in 10 Pacific island nations provide the basis for this review in which we document current and historic levels of obesity, examine factors which contribute to the risk of obesity, and describe the effects of obesity on NCD risk.

Historical record suggests that obesity has become much more common in Pacific communities since the arrival of Europeans. Early European mariners and travellers generally described Micronesian and Polynesians as having fine, muscular physiques, although they also observed that obesity was valued in individuals of high social position[1,2,7,8]. Examination of photographs taken in many Pacific communities prior to the Second World War also indicates that obesity seems relatively less frequent than is observed today.

Current prevalence

Table 1 shows the age-standardized prevalence of obesity (defined as a body mass index (BMI) > 30kg/m^2) in various Pacific populations and urban Caucasian Australians aged 25 - 69 years. Study populations generally comprised whole community samples, such as rural villages or geographically defined urban areas which were chosen on *a priori* ground as being typical of the background population. Prevalence has been age-standardized using Segi's world population as standard.

" The increased prevalence of obesity is believed to have contributed to the rise in NCD, especially NIDDM. "

Studies performed since 1990 have found prevalence of 77% in Nauruan men and women, 48% and 70% in urban Western Samoans and 28% and 38% in urban Papua New Guinean men and women respectively, and highlight the extent of the problem compared to urban Australia with prevalence of 11% in men and 13% in women[9]. Earlier studies performed around 1980 in Fiji, Kiribati, Cook Islands, Niue, Tuvalu, Wallis Island, and the Loyalty Islands, found

Table 1. Age-standardized prevalence of obesity (body mass index > 30kg/m^2) in Pacific Island and Australian men and women aged 25 - 69 years

			Men		Women	
Population	Year	Reference	n	Prevalence %	n	Prevelance %
Melanesians						
Fiji	1980	10				
Rural			197	9.4	154	24.2
Urban			331	17.8	336	40.8
Papua New Guinea	1991	21				
Rural Coastal			232	16.1	437	13.7
Urban Coastal			395	27.7	327	37.8
Highland rural & peri-urban			157	3.3	183	2.2
New Caledonia (Loyalty Islands)	1979	12	128	5.0	273	25.0
Micronesians						
Nauru	1994	*	637	77.3	707	77.1
Kiribati	1981	11				
Rural			363	11.8	377	13.1
Urban			318	47 7	426	70 4
Polynesians						
Wallis Island	1980	13				
Rural			218	24 1	188	48 1
Urban (Noumea)			253	35 9	208	65.4
Cook Island	1980	14				
Rarotonga			436	39 0	468	49 6
Niue			401	21.0	441	36 0
Tuvalu	1977	15	195	24.0	204	47 5
New Caledonia (Loyalty Islands)	1979	12	265	10.5	139	31.3
Caucasians						
Urban Australians	1989	9	4166	11.1	4250	12.7

* *Nauru (1994) unpublished. The references describe the studies*

high prevalence of obesity, especially in relatively urbanized populations[10-15]. Secular trends demonstrated in other populations, as discussed later, suggest that further increases seem likely since those early studies. Other features of these data are the female preponderance of obesity and the increased prevalence in urban versus rural populations.

A preliminary study has suggests that obesity may be overestimated in Cook Islanders when BMI is used as an indicator: at any level of BMI, European-origin Australians had relatively higher body fat as determined by bioimpedance[16]. This report is of great interest, and if replicated in other Pacific populations using more accurate methods, the implications would be that higher levels of BMI would be 'acceptable' relative to those applied to

Europeans. This relaxation has already been recommended by the South Pacific Commission. However, as discussed later, there is overwhelming evidence that increasing levels of BMI are associated with adverse health outcomes in Pacific communities, in association with modernization.

Rural-urban comparisons and migrant studies

The effect of modernization or acculturation can also be seen clearly in rural-urban comparisons and migrant studies which have consistently shown increased prevalence of obesity in members of the same ethnic group who live relatively more modern versus traditional lifestyles. As well as our studies summarized in Table 1, McGarvey reported prevalence of overweight in relatively traditional Western Samoans as 33% in men and 46% in women compared with 75% and 80% respectively in those who had migrated to urban Hawaii[17]. Tokelauans who had remained in Tokelau and smaller increases in BMI between baseline (1968-71) and 1982 than those who had migrated to New Zealand[18].

Secular Trends

Serial surveys in Nauru, Western Samoa and Papua New Guinea (PNG) allow trends in obesity prevalence to be examined (Table 2). Over the 19 year period since the first study in Nauru, there was relatively little change from the already high baseline levels up until 1987, but by 1994 there was a further increase, particularly in men and in older age-groups. By contrast, in rural Western Samoa the dramatic increase in obesity, from modest rates in 1978, has occurred mostly in the younger age groups (179% increase in men 25 - 34 years of age), and was greater than among the urban subgroup, who were more obese at the baseline. These observations are consistent with the effect of lifestyle change in promoting obesity being greatest in the younger age-groups, with subsequent increases in the older age-groups occurring as relatively more 'modernized' cohorts age. In Nauru it appears that the process is almost complete, while in rural Western Samoa there is potential for the overall prevalence of obesity to increase further.

The rural communities for which prospective data were available in PNG have relatively low levels of obesity, especially in the Highlands, with no consistent trends across age groups, and differ from other populations in that men tend to be more obese than women. Nevertheless, the differences in prevalence between the peri-urban and rural highland communities indicate the adverse effect of modernity on obesity.

Over the six and one half year period between 1975/76-1982, mean BMI of Nauruans followed longitudinally, increased in all but the oldest age group, with the most dramatic gains in the youngest group[19]. Similar findings have been reported for Polynesians in American Samoa over a 5-year period[17]. The incidence of severe overweight in subjects 18-34 years at baseline was over 30% versus less than 10% in subjects older than 54 years. Because obesity develops at a younger age in Pacific communities, and is therefore present for an extended period of life, the deleterious effects of obesity on health could be expected to be relatively greater than in populations where obesity occurs predominantly in middle-aged and elderly individuals.

Physical activity

Reduced levels of physical activity in urban versus rural subjects have been observed in Kiribati[11], Western Samoans and Melanesians and migrant Indians in Fiji[10, 20]. More directly, cross-sectional studies in Western Samoa and PNG have found that physical inactivity is independently associated with obesity, at least in men[20, 21]. Greska et al estimated that modernization of lifestyle in Samoa was associated with decreased occupational energy expenditure and found supporting evidence in poorer aerobic capacities of American Samoan compared with Western Samoan men[22]. However, the reduced aerobic capacity in less active men appeared to be a result of their increased fatness, rather than their inactivity. While not proving cause and effect the results of these studies support the hypothesis that reduced energy expenditure contributes to obesity in Pacific populations.

"Despite the strong relationships observed between obesity and CVD risk factors in Pacific populations, we have been unable to show an association between obesity and total mortality in longitudinal studies over 10 and 11 years in Nauru and Fiji, respectively."

Diet

Traditional diets in the Pacific varied depending on environmental limitations to plant and animal production. For example, in the Highlands of PNG traditional diets were based on sweet potatoes and derived 95% of energy from carbohydrate and only 2% from fat, while atoll diets based on coconut and fish provided up to 36% of energy as fat[23,24] With modernization, imported white rice, flour, sugar, and tinned meat and fish have become staples throughout the Pacific. In many cases this has increased the dietary fat content and reduced the intake of complex carbohydrate and fibre.

Table 2. Trends in prevalence of obesity (body mass index > 30kg/m^2) in men and women 25 - 69 years of age

Population	Year of study	% by age group (years) 25 - 34	35 - 44	45 - 54	55 - 69	Total	Age-standardized %
Men							
Nauru	1975/76	76.0	68.5	46 2	50.0	63 2	61.7 (54.5 - 69 0)*
	1982	76.1	69.6	71.7	50.8	70 7	67.5 (63 2 - 71.8)
	1987	77.0	78.3	50.0	47.7	67 2	64.8 (57.8 - 71.7)
	1994	82.3	81.9	77.2	69.0	80 2	77.3 (73.6 - 81 0)
Western Samoa							
Rural	1978	8.2	20 3	24.3	20.9	18.7	17.7 (13.2 - 22.2)
	1991	22.9	38 8	42.4	35.3	34.8	34.2 (29.9 - 38.6)
Urban	1978	27.7	47.4	40.8	37.7	38.2	38.8 (32.9 - 44 8)
	1991	31.0	63.6	53.1	46.2	48 4	47.7 (42.3 - 53.2)
Papua New Guinea							
Rural Coast	1983	26.1	26.7	20.8	12.5	23.5	21.4 (12.7 - 30 1)
	1991	25.7	18 5	35.5	10 0	21.0	23.0 (15.8 - 30 1)
Peri-urban Highlands	1985	7.4	10.5	4.5	0	4.8	5.8 (0.9 - 10.8)
	1991	7.4	5.9	14.3	0	6.9	6.9 (1.1 - 12.7)
Rural Highlands	1983	0	0	0	0	0	0
	1991	0	0	0	0	0	0
WOMEN							
Nauru	1975/76	73.2	83.9	60.5	62 5	72.4	69.4 (62.2 - 76.6)
	1982	72.5	81.9	83.3	69.2	75.8	76.4 (72 9 - 80.1)
	1987	70.5	74.4	74.5	62.7	69.8	70.3 (64.6 - 76.0)
	1991	77.6	83.0	74.7	72.7	78.6	77.1 (73.4 -80.8)
Western Samoa							
Rural	1978	25 0	31.2	48.6	48.6	37.9	37.0 (31 6 - 42.4)
	1991	43.7	31 2	61.2	48.6	52.1	52.2 (47.7 - 56.6)
Urban	1978	44.3	73.7	67.4	53.8	60.3	59.1 (53.8 - 64.5)
	1991	50.5	81.9	78.3	76.2	72.1	70.4 (66 2 - 74.8)
Papua New Guinea							
Rural coast	1983	12.5	33.3	8.3	0	16.9	13.9 (6.2 - 21.6)
	1991	16.7	8.1	9.8	10.8	12 3	11.7 (8.3 - 15.1)
Peri-urban Highlands	1985	0	9.1	0	0	1.8	2.3 (0.5 - 0.3)
	1991	0	9.5	6.3	0	3.1	3.8 (0.8 - 0.0)
Rural Highlands	1983	2.9	0	0	0	0 8	0.8 (0.2 - 0 4)
	1991	0	0	0	0	0	0

* *95% confidence interval*

Energy intakes recorded for rural areas are generally greater than for urban areas, reflecting greater energy expenditure in rural communities[25]. However, in two of the populations with the highest prevalence of obesity, the urbanised Wanigela people in Koki (PNG) and Nauruans, energy intakes greatly exceeded estimated requirements, by up to 50% in Wanigela women[26,27]. The fat content of these diets was similar to the level currently recommended in Australia (33% of energy) but due to the high overall energy intake, total fat intake was high. Traditional cultural practise in many Pacific communities favours feasting which may contribute to excess energy intake, especially in sedentary urban dwellers[24].

Evidence for the role of modern diet in promoting obesity is provided by two studies which examined the effect of reversion to a traditional diet. Hawaiians who reverted to a traditional low fat, high fibre diet eaten to satiety consumed significantly less energy compared to their baseline diet and lost weight rapidly, without changes in physical activity[28]. Similarly, Australian Aborigines who spent 8 weeks living a traditional hunter-gatherer lifestyle which included increasing physical activity and dietary changes also lost weight[29]. In both cases other metabolic parameters including glucose tolerance and serum lipids were also improved.

Table 3. Odds ratios (OR) and 95% confidence intervals (95% CI) for factors associated with obesity in cross-sectional analysis, Western Samoa 1991#

	Men		Women	
	OR	95% CI	OR	95% CI
Location				
Rural	1.00		1.00	
Urban	1.44	1.40 - 1.98*	1.97	1.46 - 2.65***
Educational level				
Standard 1-3	1.00		1.00	
Standard 4-6	0.84	0.38 - 1.83	1.07	0.53 - 2.15
Form 1-3	1.13	0.50 - 2.56	1.47	0.69 - 3.12
Form 4-6	1.35	0.57 - 3.16	1.49	0.69 - 3.23
Tertiary	1.18	0.41 - 3.34	1.78	0.72 - 3.15
Occupation				
Unskilled / unemployed / pensioner	1.00		1.00	
Skilled / partly skilled	1.55	1.03 - 2.32*	1.40	0.90 - 2.17
Professional / clerical	2.20	1.16 - 4.18*	3.09	1.52 - 6.29**
Physical activity				
High##	1.00		1.00	
Medium	1.52	1.03 - 2.22*		
Low	1.86	1.16 - 2.98*	1.28	0.74 - 2.23

 # Age and age ^{2} were also included in the analysis but OR are not included as they are meaningless, both were significant ($p < 0.001$) for men and women.
Three categories of physical activity in men and only two which are not directly comparable in women

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

Cultural and socioeconomic factors

In contrast to the situation in developed countries where increasing socioeconomic status is associated with slimness a recent survey in Western Samoa showed obesity to be positively and independently associated with age, urban residence, physical inactivity and high occupational status[20,30]. A higher level of educational attainment also increased the risk for obesity (Table 3). Similarly, in PNG a "modernity" score which included components for education, occupation, type of housing, and period of residence in an urban area, was associated with BMI after controlling for age and physical activity[21].

This positive association between socioeconomic status and obesity in Pacific populations is in accord with documented traditional values which associated obesity and high status. Howard found that Samoans viewed obesity as desirable and healthy in people of high status, but not necessarily in commoners[31]. However, a recent study demonstrated that an urbanised group of Samoan women were more accepting of overweight and did not associate being overweight with poor health or unattractiveness to the same extent as Australian women[32].

Age

Obesity is seen at an early age in many Pacific populations. In Western Samoa in 1991 for example the prevalence of obesity (BMI >30kg/m^2) in 25-34 year olds in combined rural and urban groups was 26% in men and 47% in women, rising to 49% in men 35-44 and 70% in women 45-54 years. The prevalence of obesity however declined in older age

groups. This is a typical pattern in the Pacific, except in Nauru where the prevalence had already peaked in the youngest group. The reduced obesity among older subjects may therefore reflect lesser adoption of modern diet and lifestyle, increased survival of leaner subjects, and/or weight loss due to concurrent illnesses.

Ethnicity and genotype

In Fiji, where Melanesians and Indians live side-by-side under apparently similar conditions, there are clear ethnic differences in the prevalence of obesity. Whether these differences are due to different genetic susceptibility to obesity or to culturally-determined lifestyle factors has not been ascertained. There is evidence however that ethnic differences in diet and activity persist even with two groups living in similar environments[25].

The thrifty genotype hypothesis proposes that a genotype favouring fat deposition during periods of abundant food offered a survival advantage to individuals in hunter-gatherer and early agricultural societies which were subject to periods of food shortage[33]. Such shortages could have occurred due to crop failures associated with the droughts and cyclones to which Pacific islands are subject, or during the long migratory canoe voyages of Pacific settlement. In modern times when high energy food is consistently available and habitual levels of physical activity have decreased, this genotype would favour obesity and non-insulin-dependent diabetes mellitus[5,33].

"Recent work suggesting that insulin sensitivity is a risk factor for weight gain and that insulin resistance limits further weight gain is however difficult to reconcile with some aspects of the thrifty genotype theory."

The metabolic expression of the thrifty genotype appears to be via selective tissue insulin resistance and relatively high basal and stimulated insulin levels[34]. Certainly, relative hyperinsulinaemia exists in Micronesians, Polynesians, Australian Aborigines and other populations who are believed to have "thrifty genotypes"[35-37]. Recent work suggesting that insulin sensitivity is a risk factor for weight gain and that insulin resistance limits further weight gain is however difficult to reconcile with some aspects of the thrifty genotype theory[38,39]. Whatever the mechanism, it seems likely that there is a genetic component in the susceptibility to obesity of Pacific populations.

Obesity and NIDDM

Cross-sectional studies in Melanesians and migrant Indians in Fiji, Micronesians in Kiribati and Polynesians in Western Samoa have found obesity, as measured by BMI, to be an important risk factor for NIDDM, especially in women[10,11,40]. This was consistent with the results of a 6-year longitudinal study in Nauruans[41]. Body fat distribution as measured by waist-hip ratio was also associated with glucose intolerance in Western Samoa and Nauru[40,42]. Cross-sectional studies are known to underestimate the effect of obesity on NIDDM as the development of diabetes is associated with weight loss. More recent but unpublished longitudinal data from Western Samoa, Nauru and PNG communities indicate clearly that obesity is a major determinant of glucose tolerance.

Obesity and cardiovascular disease

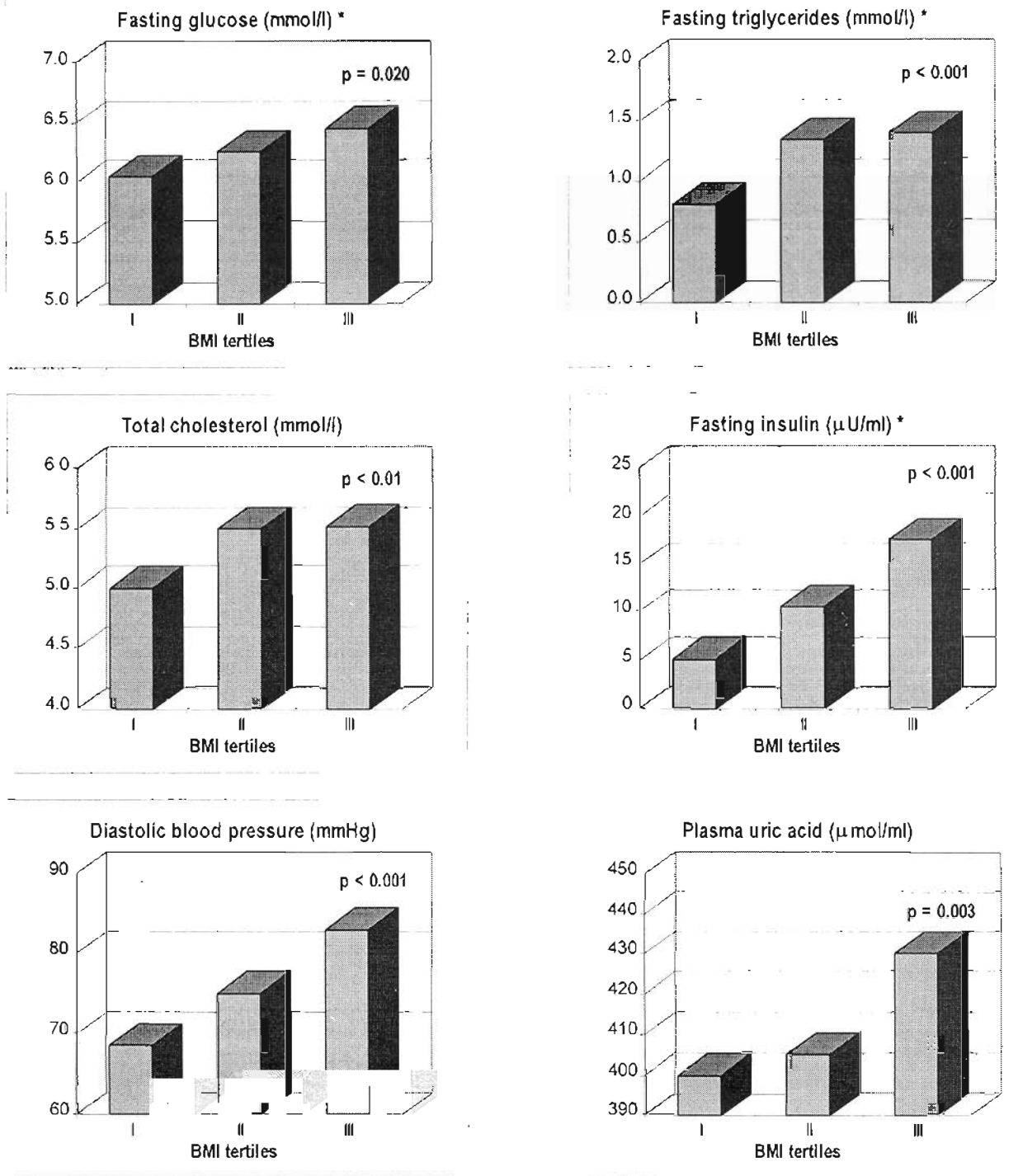
Obesity is strongly associated with cardiovascular disease risk factors in Pacific populations[3,40-44]. Figure 1 shows levels of risk factors across tertiles of BMI for Western Samoans: similar results for both BMI and waist-hip ratio have been documented for Nauruans and other Pacific populations[42]. The incidence of cardiovascular disease remains relatively low in many Pacific communities, particularly given the levels of obesity and glucose intolerance that exist, and it has been proposed that there is a lag period between the development of epidemic obesity and NIDDM, with subsequent increases in atherosclerosis and cardiovascular disease[4,5]. However, in those communities with significant acculturation there have been clear increases in rates of cardiovascular disease, and the potential for further increases is suggested by the fact that rates of coronary heart disease in Maoris and Pacific islanders in Auckland exceed those of European New Zealanders and CVD mortality in ethnic Hawaiians exceeds the overall population rate[46-49].

There is little published data directly implicating obesity as a risk factor for cardiovascular disease in Pacific populations, although it was associated with ischaemic electrocardiogram abnormalities in Fijians[50]. Given its association with CVD risk factors however, obesity must be contributing, albeit indirectly, to increases in CVD morbidity and mortality, via its effects on glucose tolerance, blood pressure and lipid levels.

Obesity and mortality

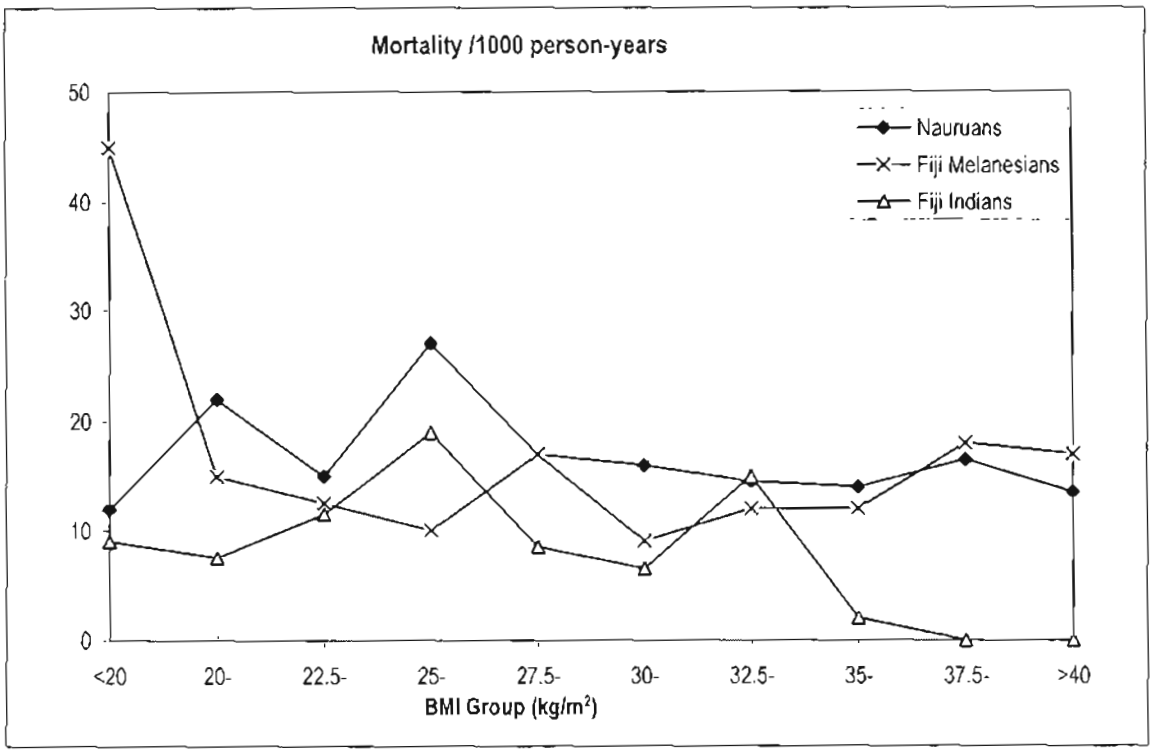
It is generally accepted that obesity is associated with an increased mortality risk in Caucasians but the situation is less clear in developing countries and little work has been published examining this association[51]. Crews found that BMI was not independently associated with total or CVD mortality in the obese population of American Samoa, although it was significant before adjusting for blood pressure[52]. Despite the strong relationships observed between

Figure 1. Relationship between obesity and age-adjusted levels of cardiovascular risk factors for Western Samoans



** Geometric means*

obesity and CVD risk factors in Pacific populations, we have been unable to show an association between obesity and total mortality in longitudinal studies over 10 and 11 years in Nauru and Fiji, respectively (Figure 2). Even when the effect of weight loss due to pre-existing severe diabetes was controlled by limiting analyses to non-diabetic individuals there was no association between obesity and mortality. However, this finding by no means exonerates obesity as a contributor to mortality in the Pacific. Mortality rates were elevated to around 3-fold in subjects with NIDDM, and



given the strong relationships between obesity and risk of NIDDM, prevention of NIDDM by maintenance of healthy body weights should reduce overall mortality in these populations.

Conclusions

The prevalence of obesity is reaching epidemic proportions in some Pacific nations, as populations presumed to have a genetic adaptation which favours fat deposition, are faced with a changing environment requiring less physical activity, and providing an unrestricted supply of energy-dense, highly palatable food. The situation could worsen as populations still living relatively traditional lifestyles are increasingly exposed to Western influences. Already NIDDM prevalence, closely associated with obesity, has reached levels as high as 30% in adults of some Pacific communities and could potentially reach similar levels in other populations[53,54]. With increasing duration of obesity and NIDDM the incidence of both CVD and diabetic complications will almost certainly rise. The resultant increase in morbidity and premature mortality could further limit the development of Pacific nations and will place an increasing burden on health services.

Pacific countries face a major challenge to find effective ways of preventing and reducing obesity. The beneficial effects of traditional diets on weight and metabolic parameters have been well demonstrated in Hawaiians and Australian Aborigines[28,29]. However, it is clearly neither practical nor desirable for Pacific communities to return to a traditional diet and lifestyle. Even in Western societies where there is greater awareness of the adverse effects of obesity, as well as a cultural desire for slimness, it has proved to be very difficult to induce weight loss and even harder to maintain it in obese individuals. In developing countries where there may be a limited choice of foods, few opportunities for leisure activities, and limited resources to support and educate people in weight control, it may be even more difficult. Hence community-wide primary prevention programs which promote healthy diets and the benefits of physical activity should be developed and implemented[55]. Beneficial aspects of both traditional and modern lifestyles must be integrated in such a way as to maximize health. Resources directed at preventing obesity and other lifestyle-related Western diseases today will be repaid in the future by savings in health care costs and improved productivity.

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" Resources directed at preventing obesity and other lifestyle-related Western diseases today will be repaid in the future by savings in health care costs and improved productivity. "