

# Cardiovascular disease (CVD) risk factors in Samoa and American Samoa, 1990-95

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## Introduction

The health effects of the alteration of traditional ways of life such as occupation, physical activity and diets by exposure to modern ways of life have been described in many studies. Most research has focussed on the energetic and metabolic consequences of modernization including the increase in adiposity and other cardiovascular disease (CVD) risk factors in adults. The purpose of this brief report is to describe some of these changes in the adult Samoan population residing in Samoa and American Samoa. Much work has been done on CVD risk factors in relation to modernization at the community and individual levels and this report summarizes some of that prior work. Conceptual and measurement issues in modernization and health are not discussed here but the interested reader can turn to other works by the author and others (Baker et al 1986, McGarvey et al 1989, McGarvey 1999). Due to space constraints, this report does not cover our work on psychosocial stress and health in modernizing Samoans (McGarvey and Schendel 1986, Chin-Hong & McGarvey 1996, Steele and McGarvey 1996, 1997).

Starting in 1975 and lasting about 8 years, The Samoan Studies Project included a number of cross-sectional measures of human biology and health among Samoans in several different locales, including California, Hawaii, American Samoa and Samoa (Baker et al 1986).

### Modernizing Samoans are characterized by high prevalence and incidence of high body mass index (BMI) and massive adiposity.

The summary here describes some of the early studies, and presents findings from fieldwork recently completed (1990-95) in Samoa and American Samoa. Most of the results described pertain to a cohort of Samoan men and women ages 25-56 years at baseline studied longitudinally over four years: 1990-94 in American Samoa, N=244 men and N=332 women; and 1991-95 in Samoa, N= 345 men and N=368 women. The Samoan sample was based on a random sample of adults chosen, with participation rates >90%, from nine villages; four from rural regions of Savai'i island, the least modernized area of Samoa, three villages from rural 'Upolu island and two villages from the urban Apia area (Chin-Hong and McGarvey 1996). The American Samoan sample was selected from village lists in over 20 villages and 10 workplaces (McGarvey et al 1993). Average age in the sample is 38 years in both

polities and average years of education is 13 in American Samoa and 10 in Samoa. Over two-thirds of men in Samoa are involved in farming and fishing occupations, most within their extended family

and village areas, but only 12% of men from American Samoa are so employed. Approximately 50% of American Samoan women are employed in wage jobs compared to 18% of Samoan women.

## Overweight and obesity

Modernizing Samoans are characterized by high prevalence and incidence of high body mass index (BMI) and massive adiposity (McGarvey and Baker 1979, Bindon and Baker 1985, McGarvey 1991, McGarvey 1995). The level of BMI and prevalence of obesity has increased from the late 1970s to the early 1990s in American Samoa and Samoa (McGarvey et al 1993, Hodge et al 1994). For example mean BMI among American Samoan men, 35-44 years of age, was 30.4 kg/m<sup>2</sup> in 1976 and 34.0 kg/m<sup>2</sup> in 1990. Similarly, mean BMI among American Samoan women, 35-44 years of age, was 34.8 kg/m<sup>2</sup> in 1976 and 36.6 kg/m<sup>2</sup> in 1990 (McGarvey et al 1993). In one urban and two rural areas of Samoa studied in 1978 and 1991, mean BMI for ages 25-74 years increased for men from 27.5 to 30.4 kg/m<sup>2</sup> and for women from 29.8 to 32.9 kg/m<sup>2</sup> (Hodge et al 1994).

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**Table 1. Distribution of BMI categories in 1994-95 and Four Year Incidence of obesity in Samoa and American Samoa, by sex and age**

BMI*	Samoa 1995				American Samoa 1994			
	Male (age yrs)		Female (age yrs)		Male (age yrs)		Female (age yrs)	
	29-43	44-60	29-43	44-60	29-43	44-60	29-43	44-60
30-34 kg/m <sup>2</sup>	23%	26%	34%	36%	31%	35%	26%	22%
35-39 kg/m <sup>2</sup>	7%	10%	13%	25%	30%	27%	27%	29%
≥40 kg/m <sup>2</sup>	3%	6%	6%	17%	20%	19%	28%	43%

  

BMI: Four Year incidence	Samoa 1991-1995				American Samoa 1990-1994			
	Male (1994-95 age)		Female (1994-95 age)		Male (1994-95 age)		Female (1994-95 age)	
	29-43	44-60	29-43	44-60	29-43	44-60	29-43	44-60
≥35 kg/m <sup>2</sup>	3%	5%	6%	17%	31%	15%	24%	33%

\*BMI - body mass index. weight (kg.)/height<sup>2</sup> (m.)

Longitudinal studies also indicate substantial weight gain continuing among already overweight adults (McGarvey 1991, Gershater and McGarvey 1995). For example American Samoan men and women, 18-34 years old, gained approximately 7 kg of weight over the 5 year period of 1976-81 (McGarvey 1991). Information on BMI from the recently completed 4-year longitudinal cohort from Samoa and American Samoa provides more evidence on Samoans= massive body size and continual adult fat accumulation. Men from American Samoa have greater BMI at all ages than their Samoan counterparts, and had greater 4-year BMI increases, especially in those 25-39 years: 2.3 vs. 0.1 kg/m<sup>2</sup>. American Samoan women of each age also had higher BMI levels than their Samoan counterparts and had greater 4 year increases; e.g. the 4-year BMI increase in 25-39 year old American Samoan vs. Samoan women was 1.4 vs 1.0 kg/m<sup>2</sup>.

In the recent 1990-5 cohort adult females had higher levels of obesity (Table 1), although in the samples from American Samoa male and female rates of overweight and obesity are becoming more similar now than in earlier studies (McGarvey 1999). Between 81-94% of men and women of all ages had a BMI >30 kg/m<sup>2</sup> in American Samoa in 1994, whereas in Samoa in 1995, the proportions of adults >30 kg/m<sup>2</sup> are less (Table 1). Nevertheless, in Samoa 42% of older men and 78% of older women exceed or equal 30 kg/m<sup>2</sup> in body mass. Recent body composition research among Polynesians suggests that using >30 kg/m<sup>2</sup> as a criterion for obesity overestimates the prevalence of obesity and that a better criterion is approximately >32 kg/m<sup>2</sup> (Swinburn et al 1999). Thus, in Table 1 using BMI >30 kg/m<sup>2</sup> may overstate the proportion of obesity and it may be better to use >35 kg/m<sup>2</sup> as a criterion.

The incidence of BMI>35 kg/m<sup>2</sup> over four years is much higher in American Samoan men and women of all ages

compared to their counterparts in Samoa (Table 1). The incidence estimates support the cross-sectional surveys done at different time periods in the Samoan island populations and indicate the continual increase in adiposity among the most modernized American Samoans.

The temporal trends in diet and physical activity indicate that a chronic positive energy balance among Samoans is largely responsible for the considerable levels of body weight and fat (Baker et al 1986, Greksa 1986, McGarvey 1991, 1999, Galanis et al 1999). Genetic epidemiology research on weight and obesity among Samoans of all ages is commencing and perhaps this will provide some evidence for novel genetic and physiologic influences. Special emphasis is being placed on the detection of potential interactions between specific environmental factors such as physical activity levels or dietary composition and the genetic factors involved in susceptibility to overweight at specific ages or in one gender. It is important to assert that studies from the last 50 years show that the macro-environmental influences of modernization ultimately have caused the epidemic levels of overweight and obesity in all Polynesians (Zimmet 1979, Baker 1984, McGarvey 1994, 1995). Any future evidence of the putative role for genetics in the increase in obesity among Samoans must be interpreted in the context of the massive changes in the diet and physical activity patterns in the Pacific.

## Hypertension

Blood pressure levels and hypertension have been studied systematically in Samoans for over 20 years because of their close association with patterns of overweight and obesity (McGarvey and Baker 1979, Zimmet et al 1980, McGarvey and Schendel 1986, McGarvey 1992). In general, blood pressure levels and hypertension prevalence increase with adult age in the more modern-

**Table 2. Prevalence of hypertension in 1994-95 and Four Year Incidence of hypertension in Samoa and American Samoa, by sex and age**

	Samoa 1995				American Samoa 1994			
	Male (age yrs)		Female (age yrs)		Male (age yrs)		Female (age yrs)	
	29-43	44-60	29-43	44-60	29-43	44-60	29-43	44-60
Hypertension*								
Hypertension I	22%	31%	3%	25%	41%	60%	24%	42%
Hypertension II	7%	14%	1%	9%	28%	40%	10%	10%

  

	Samoa 1991- 1995				American Samoa 1990-1994			
	Males (1994-95 age)		Female (1994-95 age)		Male (1994-95 age)		Female (1994-95 age)	
	29-43	44-60	29-43	44-60	29-43	44-60	29-43	44-60
Hypertension: Four Year Incidence								
Hypertension I	18%	26%	2%	19%	34%	52%	20%	35%
Hypertension II	5%	13%	1%	8%	29%	38%	8%	21%

\*Hypertension I: Blood pressure  $\geq$  140/90 or on anti-hypertensive medications.

Hypertension II: Blood pressure  $\geq$  160/95 or on anti-hypertensive medications.

ized Samoan groups relative to those with a more traditional way of life (McGarvey and Schendel 1986). Blood pressure is strongly related to measures of adiposity in Samoans of all ages, both sexes and at all levels of modernization.

Earlier in our Samoan blood pressure studies is seemed that the proportions of adults with hypertension was less than we might expect given the levels of body mass and adiposity. However, the recent studies indicate very high rates of hypertension, especially among the American Samoan samples (Table 2). Approximately 60% of American Samoan men, and more than 40% of women, 44-60 years of age have hypertension based on blood pressure greater than or equal to 140mm Hg for systolic or 90 mm Hg for diastolic pressure, including those on anti-hypertensive medications. In older men and women from Samoa, these same sample prevalences are 31% and 25%, respectively, which indicate a substantial public health problem throughout both Samoas. The four year incidence of hypertension is quite striking in all sub-samples, except younger women from Samoa (Table 2). For

example, among younger adult American Samoans, the 4-year incidence of hypertension (defined as blood pressure  $>$  140/90 or on anti-hypertensive medication) is 34% for men and 20% for women. The incidence of established hypertension (Hypertension II in table 2, i.e. blood pressure  $>$  160/95 or on anti-hypertensive medication), among all older Samoans is noteworthy, especially among the American Samoans (Table 2).

We are investigating some of the biological and behavioral factors responsible for these worrisome hypertension findings, including adiposity, hyperinsulinemia, dietary sodium and potassium and aspects of psychosocial stress. For example, preliminary analysis of sodium and potassium intake based on overnight urine collections shows that potassium excretion rates, and thus intake, were much higher among Samoans of both sexes compared to their American Samoan counterparts (McGarvey 1999). This difference is likely due to retention of some parts of the traditional diet in Samoa, especially banana consumption, compared to American Samoans (Galanis et al 1999). There are many other factors

**Table 3. Prevalence of diabetes in 1994-95 and Four Year Incidence of diabetes in Samoa and American Samoa, by sex and age**

	Samoa 1995				American Samoa 1994			
	Male (age yrs)		Female (age yrs)		Male (age yrs)		Females (age yrs)	
	29-43	44-60	29-43	44-60	29-43	44-60	29-43	44-60
Diabetes*								
Prevalence	1%	6%	3%	8%	11%	36%	15%	15%

  

	Samoa 1991- 1995				American Samoa 1990-1994			
	Male (1994-95 age)		Female (1994-95 age)		Male (1994-95 age)		Female (1994-95 age)	
	29-43	44-60	29-43	44-60	29-43	44-60	29-43	44-60
Diabetes: Four Year Incidence**								
Prevalence	1%	4%	1%	4%	9%	16%	9%	8%

\*Type 2 Diabetes - Fasting Serum Glucose  $\geq$  126mg/dl.

\*\*Four Year Incidence - proportion of new cases of Type 2 Diabetes at the 4-year follow-up among those without diabetes at baseline.

contributing to elevated blood pressure levels that also change with modernization including other dietary factors, physical activity levels, body fat and stress, and potential interactions with unknown genetic influences. Our future work will focus on uncovering some of these etiologic factors. Meanwhile, public education about hypertension, and surveillance, case detection and treatment must be increased throughout the modernizing Samoan populations.

## Type 2 diabetes

Type 2 diabetes has been a focus of much research in Pacific island populations experiencing economic development (Zimmet 1979). Zimmet and his colleagues showed differences in diabetes prevalence between rural and urban areas of Samoa in the late 1970s (Zimmet et al 1981) and in the early 1990s, as well as a marked increase in Type 2 diabetes over 13 years (Collins et al 1994).

Table 3 shows the prevalence of Type 2 diabetes in our work in 1994 and 1995 in both Samoa and American Samoa, as well as the 4-year diabetes incidence in 1,289 adults studied twice in that period. The data shown in Table 3 are based on a single fasting serum glucose specimen and the recent diagnostic criterion for epidemiologic studies: Type 2 diabetes is defined as fasting glucose  $\geq 126$  mg/dl. One further contrast of these prevalence estimates with those from Zimmet's group is the specific villages chosen for study (see above). Thus, extrapolation from the general trends in Zimmet's studies and the preliminary data shown here are similar but the absolute estimates are somewhat different. No previous reports have been made of diabetes prevalence or incidence for American Samoa.

Diabetes prevalence is much higher for all age-sex groups in American Samoa relative to Samoa (Table 3). More than one-third of older men from American Samoa have Type 2 diabetes. The incidence rates indicate that glucose intolerance is increasing rapidly throughout all Samoa. The four-year incidence is striking in American Samoa, slightly less than 10% in all sub-samples. The greatest risk of developing diabetes was among those

who had impaired fasting glucose (109 mg/dl < fasting glucose < 126 mg/dl), and a BMI  $\geq 35$  kg/m<sup>2</sup>.

Targetted or general adult population screening for Type 2 diabetes must be evaluated because of the notable diabetes prevalence and incidence and the health and cost implications for diabetes-related morbidity. It may be difficult to increase patient and provider knowledge of diabetes, and in changing attitudes and behaviors about the danger of fatalism and the need for lifetime diabetes management strategies. This was the topic of the recent 5th International Conference on Diabetes in Indigenous Peoples held in Christchurch, New Zealand, which was attended by the author and several health professionals from Samoa and American Samoa. There are grounds for hope for public health action about diabetes and the need for appropriate applied and basic research.

## Blood lipid and lipoprotein levels

Total cholesterol levels were lower and HDL-cholesterol levels higher than expected in the early studies of Samoans, considering their adiposity (Pelletier and Hornick 1986). In our 1990-91 cross-sectional studies with adult Samoans, who average greater body weight than earlier samples, cholesterol levels and HDL-cholesterol levels had worsened and suggested increasing risk of CVD (McGarvey et al 1993, Galanis et al 1995). Table 4 offers a preliminary description of the proportion of Samoans with high total cholesterol, high low-density lipoprotein (LDL) cholesterol and low high-density lipoprotein (HDL) cholesterol in the 1994-95 studies. Lipid studies were performed only on a sub-sample in the 1990-91 studies, so no longitudinal or incidence analyses are shown here.

The overall pattern of lipid and lipoprotein risk for adult Samoans in Table 4 is very alarming! The levels of saturated fat in the diet, due to consumption of coconut products among Samoans and animal products among American Samoans, the massive adiposity and relative physical inactivity all potentially contribute to these patterns. The high proportion of American Samoans of all ages with low HDL-cholesterol levels and high LDL cholesterol suggests a substantial proportion of the American

**Table 4. Prevalence of Lipidemia in 1994-95 in Samoa and American Samoa, by sex and age**

	Samoa 1995				American Samoa 1994			
	Male (age yrs)		Female (age yrs)		Male (age yrs)		Female (age yrs)	
Cholesterol*	29-43	44-60	29-43	44-60	29-43	44-60	29-43	44-60
High Serum Cholesterol	36%	52%	31%	54%	48%	39%	32%	57%
High LDL Cholesterol	49%	66%	41%	66%	60%	58%	53%	71%
Low HDL Cholesterol	17%	23%	34%	50%	57%	56%	75%	78%

\*High Cholesterol -  $\geq 200$  mg/dl.

High LDL Cholesterol -  $\geq 130$  mg/dl.

Low HDL Cholesterol -  $<32$  mg/dl for men and  $<40$  mg/dl for women.

**Table 5. Prevalence of current cigarette smoking in 1994-95 in Samoa and American Samoa, by sex and age**

Cigarette smoking	Samoa 1995				American Samoa 1994			
	Male (age yrs)		Female (age yrs)		Male (age yrs)		Female (age yrs)	
	29-43	44-60	29-43	44-60	29-43	44-60	29-43	44-60
Prevalence	56%	60%	27%	22%	43%	51%	36%	19%

Samoaan adults population may be at increased risk for CVD. Further research is needed on the causes and consequences of these serum lipid levels, as well as the impact of any healthful behavioral changes.

## Cigarette smoking

The proportion of adults who report current cigarette smoking is greater in American Samoan men compared to Samoan men, especially in younger men (Table 5). Among women, a higher proportion of younger women from American Samoa report cigarette smoking than their Samoan age counterparts, with little difference among older women. One speculation is that these differences may be related to the greater exposure to health education information about smoking in the public media in American Samoa which is similar to US mainland based print and electronic media. However, little research has been performed on tobacco use in the Samoan populations.

## Conclusion

These findings on the alarming levels of CVD risk factors indicate that there will future increases in CVD morbidity and mortality among Samoans, such as cerebrovascular events, coronary heart disease and kidney disease. More epidemiologic research is needed to understand the likely impact of these increasing risk factor levels on the public health of Samoans. Of course, there must be an increased provision of health care, both preventive and curative. Applied and basic research can help make this health care effective within the unique socio-cultural and behavioral context of modernizing Samoa. For example, we are planning new applied demonstration research on provision of primary health care aimed at a partnership between patients and providers that can help the management and reduction of CVD risk factors. This concise review of the older and more recent data on CVD risk factors among Samoan adults convinces the author that a collaborative interdisciplinary perspective is necessary for health care practitioners and researchers who want progress in understanding the etiology of these risk factor levels and how to reduce them. The implications of these findings lead to many further applied questions about public health interventions as well as basic questions about biological and social processes which will require several investigators sharing ideas, measures and perspectives. Further, longitudinal evaluation research must

be done to improve our understanding of the success of interventions. Similarly, longitudinal studies of the basic biological, social and behavioral processes of modernization and health must be continued to better understand the many alterations in ways of life and their interrelations. A mixture of quantitative biological and social science techniques with qualitative and ethnographically-informed studies are needed to interpret the contextual nature of adaptive processes and health outcomes for individuals and population groups during economic modernization.

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Half of the secret of resistance to disease is cleanliness;  
the other half is dirtiness.

**Anonymous. From J. Dainth and A. Isaacs Medical Quotes**