

Thrifty genotype concepts and health in modernising Samoans

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Thrifty genotype concepts are described and applied to the case of increasing overweight with modernisation. The prevalence of overweight (BMI ≥ 30 kg/m²) among American Samoans and Western Samoans is increasing substantially as described in surveys conducted in 1976-82 and in 1990-91. There is a possible role of insulin and the sympathetic nervous system in weight gain and energy balance. The thrifty genotype concept provides important hypotheses which can be applied to concrete studies among modernising Samoans.

Introduction

The role of evolutionary events in structuring genetic influences on disease has received increased theoretical and empirical attention¹. One of the most cited ideas has been the thrifty genotype concept of Neel². Neel speculated that the increase in the prevalence and incidence of diabetes mellitus in Western industrial populations, and those experiencing modernisation, was associated with genetic factors which in the past had favoured storage of calories in the form of adipose tissue in response to natural selection during food shortages. Individuals possessing tendencies towards "thriftiness" or metabolic efficiency might have been healthier, survived longer, and had more offspring³. With lifestyle changes due to economic modernisation there were increases in available food energy and decreases in energetic expenditure from lower physical activity. Thus, the advantage for a "thrifty" genotype in lean times became a disadvantage in times of plenty, leading to overweight, hyperinsulinaemia, and eventually development of glucose intolerance and diabetes mellitus.

This paper describes some of the research we are conducting among modernising Samoans, and illustrates the utility of thrifty genotype ideas for generating concrete studies of health and social change. Results on Samoan overweight, already reported using overweight criteria from US studies will be reported here using another criterion more in favour with other Pacific researchers.

Because of the widespread overweight and obesity characterising modern Pacific peoples, especially Polynesians, thrifty genotype ideas have proved very attractive to researchers working on biological and health studies with Pacific Island populations^{4,7}. Many of these studies were summarised and reported in a recent paper on evolutionary and adaptive perspectives on adiposity and the "thrifty" genotype among Polynesians³. Briefly, the large body weight and adiposity of contemporary adult Polynesians were not present at the time of European contact, although the tall

stature, rugged skeletal frame size and muscularity were described. Survey work across Polynesia from the 1960s and later did show differences in weight, body mass and fatness between rural versus town or traditional versus modernised lifestyles. There is a clear gradient of adiposity with degree of modernisation, as body mass index (BMI) values increase steadily in men and women with degree of modernisation. Also, at each step of the traditional to modern continuum women have larger BMI values than men. Further increases in Polynesian overweight and adiposity were documented in other surveys and longitudinal follow-up of individuals³.

Considerations of the discovery and settlement of Polynesia and their energetic and survival risks has led to a detailed evolutionary scenario in which tendencies to adipose deposition might have been advantageous for the first Pacific Islanders^{3,5}. We and others have also delineated how genetically-influenced "efficient metabolisms" may play a role in the relations among overweight, adiposity, individual and family patterns in insulin secretion, insulin resistance and the development of Type II diabetes⁸⁻¹⁰.

Brief review of Samoan overweight results

A series of cross-sectional studies have described the striking overweight and adiposity among modern Samoans residing in California, Hawaii, American Samoa and Western Samoa¹¹⁻¹³. Repeat representative surveys in American Samoa across 14 years also demonstrated the continued increase in age-specific overweight in young males and severe overweight in females of all ages¹⁴. Five-year and fourteen-year longitudinal results in American Samoa also showed continued increases in weight and greater proportions in the overweight and severely overweight categories, especially among younger adults^{7,15}. This occurs despite pre-existing large body weight and significant adiposity.

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The cross-sectional data were compiled and summarised in one report using BMI criteria for overweight and severe overweight specific to percentiles from a US national survey⁷. This approach made for difficult comparisons with other studies, particularly those using $\geq 30 \text{ kg/m}^2$ as the criterion for obesity. In this paper, I report the data on overweight, using $\geq 30 \text{ kg/m}^2$ as the criterion, in American Samoa from surveys conducted in 1976-78⁷ and in 1990¹⁴, and in Western Samoa from surveys conducted in 1979-82⁷ and in 1991^{16,17}. The earlier Western Samoa data came from total population surveys of three rural villages on 'Upolu. The later survey in Western Samoa was a randomly selected sample (>90% participation) from nine villages including four from Savai'i, a very rural and traditional area, three from rural 'Upolu and two from Apia, the capital and urban center¹⁶. Comparisons are made across study period within American Samoa and Western Samoa, and also between American and Western Samoa with similar time periods. Within Western Samoa, overweight is compared also between 1978-82 and 1991 only for the three rural 'Upolu villages which are similar to each other in proximity to Apia. In fact one of the three villages was studied both in 1982 and 1991.

In American Samoa, females had a higher proportion of overweight than males at the earlier time but that difference narrowed by 1990 (Table 1). American Samoan males had a significantly greater proportion of overweight at all ages in 1990 than 12-14 years earlier, whereas this was true only among the youngest and oldest females (Table 1).

Table 1. Proportion of overweight (BMI $\geq 30 \text{ kg/m}^2$) by age and sex in the 1976-78 and 1990 American Samoa samples.

Age	25-34	35-44	45-54	55-64
Males				
1976-78 %	50.3	49.6	53.7	37.4
N	157	133	175	147
1990 %	66.7	72.7	77.8	78.3
N	93	117	90	23
p value	<0.01	<0.001	<0.001	<0.001
Females				
1976-78 %	63.0	78.0	78.7	64.1
N	227	254	249	153
1990 %	73.9	83.3	82.8	84.8
N	142	150	87	46
p value	<0.03	n.s.	n.s.	<0.01

p value - probability of Chi-square test testing the difference in overweight between the two time periods.

In Western Samoa the comparisons of all villages studied in 1991 with the three rural 'Upolu villages seen in 1979-82 showed significant increases in overweight over time in young males and middle aged females only (Table 2). The better comparison of temporal changes in overweight in Western Samoa is based on the three rural 'Upolu villages (Table 3). In males, there was a non-significant trend for more overweight in 1991 in those 25-34 and 45-54 years, and a significant difference in those 35-44 years. In females, there was a similar temporal difference in those 45-54 years. There were absolute differences in overweight at other ages, although small sample sizes affected the ability to detect significant differences (Table 3).

Table 2. Proportion of overweight (BMI $\geq 30 \text{ kg/m}^2$) by age and sex in the 1979-82 and total 1991 Western Samoa samples.

Age	25-34	35-44	45-54	55-64
Males				
1979-82 %	6.5	22.2	25.0	35.7
N	46	36	44	28
1991 %	19.2	45.6	33.3	50.0
N	146	103	90	8
p value	<0.04	<0.02	n.s.	n.s.
Females				
1979-82 %	31.3	42.2	50.0	56.3
N	67	45	48	32
1991 %	39.7	60.8	67.7	100.0
N	156	120	99	4
p value	n.s.	<0.03	<0.04	n.s.

p value - probability of Chi-square test testing the difference in overweight between the two time periods.

Table 3. Proportion of overweight (BMI $\geq 30 \text{ kg/m}^2$) by age and sex, 1979-82 and 1991 rural 'Upolu villages, Western Samoa

Age	25-34	35-44	45-54	55-64
Males				
1979-82 %	6.5	22.2	25.0	35.7
N	46	36	44	28
1991 %	17.3	43.2	42.9	50.0
N	52	37	28	2
p value	<0.10	<0.05	<0.10	n.s.
Females				
1979-82 %	31.3	42.2	50.0	56.3
N	67	45	48	32
1991 %	41.4	55.6	73.0	0
N	42	45	37	0
p value	n.s.	n.s.	<0.03	--

p value - probability of Chi-square test testing the difference in overweight between the two time periods.

Overall, overweight was more prevalent in American Samoans than in Western Samoans for almost all age-sex groups at both times, especially in the earlier time.

These results for American Samoa are obviously similar to those using the same data but a different criterion for overweight¹⁴. The 1991 Western Samoan results here for the three rural 'Upolu villages are similar to results from a recent study which included rural 'Upolu villages, except in the youngest age group¹⁸.

It is reasonable to conclude from our and other's Samoan results that a high prevalence of overweight and increasing overweight over time is causally associated with societal modernisation and the individual level behaviours related to energy balance. The question remains, however, is the increase in overweight with the temporal processes of modernisation also due to an interaction with a population level genetic susceptibility?

Thrifty genotype, insulin and cardiovascular health

Some of the mechanisms proposed for the thrifty genotype involve insulin levels, hyperinsulinaemia and insulin resistance. This has led to a fuller examination of insulin's role in many cardiovascular risks factors and disease

processes¹⁹⁻²⁵. Landsberg offered a comprehensive review demonstrating the associations among insulin levels, energy balance, weight gain, sympathetic nervous system stimulation and blood pressure regulation¹⁹. However, many questions remain about the exact mechanisms linking insulin levels to these and other cardiovascular risk factors. Populations experiencing modernisation with sharp changes in diet, physical activity, weight and insulin levels provide many opportunities to study the longitudinal relations among insulin and health and their biological and behavioural contexts^{3,5,8}.

Conclusion

The thrifty genotype concept and its refinements can provide ideas for further research on insulin's influence in several

aspects of cardiovascular health status, especially in modernising groups. If such ideas allow us to hypothesise operational relations about insulin, adiposity and cardiovascular disease with concrete variables, then the thrifty genotype concept still holds value as a source of research questions.

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