Lessons from the South Pacific: The Samoan Studies Project

by

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The Samoan Studies Project

- Formulated in 1974 to investigate the biological consequences of modernization among Samoans
- First fieldwork conducted among Samoan migrants to Hawaii, 1975
- Subsequent fieldwork done in Western Samoa, American Samoa, Hawaii, and California

Why Samoa?

- ISLAND SETTING ENSURES POPULATION BOUNDARIES
- WELL KNOWN POPULATION ETHNOGRAPHICALLY, ECOLOGICALLY
- HISTORICAL CHANGES IN POPULATION IN PAST 50 YEARS PROVIDE A “NATURAL EXPERIMENT”

Basic Principles

- Adaptation to the environment by natural selection
- Population gene pool is molded by past events which shape natural selection
- “Thrifty Genotype Model”
- Social influences on human biology
- Behavior and its cultural context affects health
- “Sociocultural Model of Disease Risk”

Blood Pressure by Modernization

(Modified from Waldron et al. 1982)

Diabetes Rates among Adults of Various Populations
Thrifty Genotype (TG) Model

- Neel (1962) noted that Type II diabetes was unequally distributed across human populations.
- He reasoned that the populations with the highest diabetes prevalence were likely to have undergone cyclic episodes of severe resource deprivation.
- He postulated a model of natural selection favoring energetic efficiency for these populations.

Thrifty Genotype in Feast

- High caloric intake, relatively low activity expenditure.
- TG individuals more efficient at handling excess calories due to hyperinsulinemia.
- Circulating insulin activates lipoprotein lipase on the capillary surfaces which hydrolyzes triglycerides in the plasma to facilitate transfer into adipose cells.
- Insulin also inhibits hormone sensitive lipase which is instrumental in hydrolyzing triglycerides stored in adipose tissue and releasing fatty acids into plasma.
- Leaves them better adapted to undergo subsequent deprivation and cold stress.

Thrifty Genotype in Famine

- Low caloric intake, relatively higher activity expenditure.
- TG individuals have higher energy stores in adipose tissue to draw on to meet needs.
- Negative effects of TG such as reduced insulin sensitivity in peripheral cells and excess adiposity are counteracted by reduced caloric availability.

Thrifty Genotype in Energy Balance

- Moderate to high caloric intake and expenditure.
- No excess energy to process.
- TG individuals not at a selective advantage or disadvantage.
- High levels of activity normal for pre-modern societies counteract insulin resistance in peripheral tissues.

Thrifty Genotype in Small Chronic Excess

- Low to moderate caloric intake and expenditure.
- Intake exceeding expenditure by as little as 10 Kcal/day or one bite of apple.
- TG individuals efficiently process excess calories due to chronic hyperinsulinemia.
- Predisposed to obesity (lipogenesis).
- Type II diabetes (insulin resistance).
- Cardiovascular diseases (hypertension).
Elements of Modernization

- Cash economy
- Increasing engagement in world economy
- Formal education system
- Training needs for cultural competence exceeds what the family can give
- Secular governance
- Movement away from kin and religion based governance
- Urban units
- Significant aggregations of population in size, number, and density

Modified by Modernization

- Diet
  - Increases dietary stability, calories, calories from fat, salt
  - Decreases fiber
- Physical activity
  - Decreases energy expenditure in work and leisure activity
- Psychosocial stress
  - Increases stress in a variety of ways

Shifts in the Adaptive Landscape

- 3,000 - 5,000 years ago: Voyaging to settle the islands of Polynesia
- Selection for thrifty genotype
- 30 - 50 years ago: Modernization changes lifestyle, behavior
- Thrifty genotype becomes detrimental as it predisposes to obesity, diabetes, cardiovascular diseases

Pacific Islands

Nearest geographic and biological neighbors are the Polynesian inhabitants of the Islands of Tonga

The South Pacific

Barrier: Samoa
Voyaging

What they were looking for

Thrifty Genotype Benefits for Samoans

- Survival of the Fattest
- Insulation from cold especially in voyaging canoes
- Storage of energy for period of limited food availability
- During voyage
- Before gardens are producing after landfall
- Selection maintained by periodic storms and famine

Villages built along coastline

Swidden agriculture
Taro gardens

Coconuts

Reef Resources

Deep sea resources

Pigs

Traditional Samoan Subsistence Regimen

- Breadfruit
- Banana
- Coconut
- Taro
- Other cultigens carried on boats

- Birds and Bats
- Chickens
- Pigs
- Dogs
- Shellfish and Fish
**Missionaries**

**Partitioning of the Islands**
- Treaty signed by the three powers in December 1900
- Germany takes over large islands west of 171 west longitude
- The U.S. controls the small islands east of that line
- Great Britain receives concessions in Tonga and the Solomon Islands

**Culture Contact and Change in the 19th Century**
- Missionaries open up Samoan Islands in the 1830s
- Whalers and traders use Samoa as a port of call from 1850 on
- Colonial competition between Germany, Great Britain, and the U.S. starting in the 1880s

**Western Samoa in the 20th Century**
- Germans try to establish plantations
- Melanesians imported as workers
- New Zealand Protectorate in 1918
- Independence in 1962
- Minimal economic development
  - < 50% of men earn wages
  - < 15% of women earn wages

**Samoan Archipelago**
American Samoa in the 20th Century

- Naval base in the Pago Pago Harbor, more G.I.s than Samoans during WW II
- Navy withdraws in 1951 causing economic depression, outmigration
- “Great Society” accelerates economic development in 1960s
  - >70% of men earn wages
  - >30% of women earn wages

Pago Pago Bay Area

Migrants to Hawaii

Weigh and Measure

Prevalence of Obesity among Samoan Adults

- Western Samoa: 29.6% Men, 32.4% Women
- American Samoa: 30.0% Men, 36.0% Women
- Hawaii: 67.2% Men, 54.1% Women

Check for Diabetes
Prevalence of Diabetes among Samoan Adults

- Western Samoa: Men 4.0, Women 5.5
- American Samoa: Men 27.2, Women 20.6
- San Francisco: Men 18.0, Women 9.0

Measure Blood Pressure

Prevalence of Hypertension in Samoan Adults

- Western Samoa: Men 7.9, Women 6.4
- American Samoa: Men 22.7, Women 27.7
- Hawaii: Men 22.7, Women 13.4

Modernization and Health

- Nonlinear association between modern lifestyle and health
- Threshold model, lifestyle in American Samoa sufficient to trigger obesity, diabetes, hypertension
- More modern settings like Hawaii and California permit better adaptation to modernization

Assess Diet

Diet

- Diet shows no association with obesity
- blood sugar levels
- blood pressure
- Total calories, calories from fat, total fat, total fiber, salt intakes and types of foods consumed found not to be associated with any of the health outcomes (Bindon 1982; 1984; 1988)
**Evaluate Activity**

Activity

- Activity is associated with obesity but not blood sugar or blood pressure
- More active Samoans are less likely to be obese (Bindon 1982; 1994)
- Activity is not associated with blood sugar or blood pressure (Knight 1993)

**Association of Obesity and Activity**

- Psychosocial stress is associated with blood sugar and blood pressure but not obesity.
- Samoan men with congestive lifestyles have higher blood sugar and higher blood pressure (Bindon et al. 1991; Bindon et al. 1994)
- Samoan women do not show the same lifestyle-outcome associations (Bindon et al. 1994; Knight 1993)

**Measure Stress**

- Apolipoprotein E*4 relative to Apo E*3 is associated with:
  - Lower weight, Body Mass Index, and arm circumference
  - Lower percent glycated hemoglobin
  - Lower systolic blood pressure
  - Sources: Crews et al. (1991); Crews (1994)
Conclusions

- The relationship between modernization and health is much more complicated than anticipated—threshold effect
- Important to know the history of the population to understand genetic predispositions
- Lifestyle influences can be expected to operate differently on segments of the population