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# Impacts of Long-Term Obesity on the Health Status of Samoan and Tongan Men in the United States: Results from the Pacific Islander Health Study

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**Objective:** To examine the impacts of long-standing obesity (BMIs ≥ 30.0 kg/m$^2$) on health outcomes among Samoan and Tongan men (aged ≥ 18 years) in California using a life course perspective.

**Design:** Cross-sectional analysis of 103 males from the Pacific Islander Health Study (PIHS), a probability sample modeled after the National Health Interview Survey (NHIS).

**Setting:** Urban residential neighborhoods in San Mateo and Los Angeles counties using a multistage, cluster sample design.

**Main Outcome Measures:** BMI, diabetes, hypertension, total cholesterol, smoking, drinking, arthritis, gout and migraines.

**Results:** Bivariate analysis shows high rates of poor health outcomes distributed throughout the obese and non-obese sample. Logistic analysis finds that being obese does not significantly increase observed negative health outcomes. After controlling for socio-demographic characteristics, the presence of obesity results in non-significant findings for hypertension (OR=1.02; CI: .21, 4.91), and high cholesterol (OR=.52; CI: .10, 2.73), while obesity significantly reduces the risk of diabetes by 60% (OR=.40; CI: .14, 1.17). When applying disease counts, obese men have a significantly lower risk of reporting multiple health conditions (OR=.72; CI: .52, 1.00).

**Conclusion:** Overall, the health of Samoan and Tongan males in California is uniformly poor and obesity alone does not significantly increase risks of poor health outcomes. Using a life course perspective, the analysis offers new insights on the basic health of this understudied population. *Ethn Dis*. 2015;25(3):279-286.

## Introduction

The impacts of long-term obesity on health have been a growing concern in both health and social research.[1-3] Obesity has become closely associated with increased risk for numerous conditions, including hypertension, diabetes, coronary heart disease, and stroke.[4-6] More recent research suggests that obesity also increases *the lifetime* risk for cancer, osteoarthritis and Alzheimer's disease.[7-9] As many of these findings are based upon prevalence data that measures overall level of obesity at a specific time, this provides an incomplete measure of how obesity impacts health outcomes. The health risks associated with obesity are much better studied from a life course perspective as the negative impacts associated with weight increase occur over time as the body attempts to compensate for the demands obesity places upon the body. This article uses a life course approach to examine the effects of body size on health outcomes among Native Hawaiian and Pacific Islanders (NHPI).

The relationship between persistent and pervasive obesity across the life course among NHPI populations[10,11] has been routinely commented upon with researchers such as Okihiro and Harrigan reporting that Pacific Islanders have the highest rates of obesity in world.[12] This perception of the obese Pacific Islander has become so pervasive that it is often treated as a stereotype for this population in portrayals like the 1950s Broadway musical *South Pacific* and more recently in the 2002 Disney movie *Lilo and Stitch*.[13,14] Despite these stereotypes, however, growing awareness of the health costs of obesity has influenced attitudes within the Pacific Islander community. Work by

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Brewis et al, for example, suggested that Samoan's perception of obesity as a positive attribute was changing and many Samoans were actively seeking to lose weight for health reasons.[15]

The relationship of obesity and health outcomes among Pacific Islanders is also found in the biomedical literature, particularly in relation to the prevalence of diabetes,[16-18] as well as numerous studies that employ a community-based research approach.[19,20] While informative, many of the studies that address NHPI populations share issues related to small sample size, non-representative sampling and lack of generalizability reflecting the need for robust and statistically reliable health data on Pacific Islanders in the United States.[21,22]

## Methods

### Pacific Islander Health Study: Design and Sample

Our analysis looked at obesity issues using data from the Pacific Islander Health Study (PIHS), a representative probability survey of two ethnic Pacific Islander populations—Samoans and Tongans in California.[23] The study used a multistage sampling design to collect demographic, socioeconomic and health information that allows for direct comparisons with state and national level health data. Of the 300 households selected for PIHS, interview teams ultimately administered surveys to 240 households.[24] Our analysis examined the resulting survey data from adult males (aged ≥18 years) and included 103 males, of which 76 were obese and 27 were either normal weight or overweight.

The PIHS analysis examined the long-term impacts of obesity on health outcomes among males ≥18 years by measuring BMI at the time of survey administration and from retrospective reports on past weight of participants. Using these data, it is shown that the path to obesity starts early among Pacific Islander males with approximately 25% of participants reporting obesity (BMI > 30kg/m$^2$) and 42% reporting being overweight (BMI > 25 < 30 kg/m$^2$) at aged 18 years. By the time of the PIHS survey in 2012, the level of obesity among adult males had increased to almost 80%.

Building upon a reported pattern of obesity across the life course, our analysis examines whether high rates of long-standing obesity seen among Samoan and Tongan men results in poor health outcomes for chronic health concerns, such as hypertension, diabetes and high cholesterol, often considered endemic in Pacific Islander populations [25] and less common conditions such as migraines, gout and ulcers, which have been found to be associated with obesity. The research literature on obesity would lead us to expect that Pacific Islander males, most of whom have been overweight or obese from aged 18 years, would be at very high risk of experiencing health disorders commonly associated with obesity.[26] Our analysis is the first to look at these issues in a systematic manner using representative NHPI data.

### Statistical Analysis

The PIHS is a representative sample that post-stratifies its analysis weights to make it representative of the Samoan and Tongan populations living in California.[24] The analyses were performed using the SAS statistical software version 9.4. Multivariate analysis uses a logistic regression model where our dependent variable was Obese coded as "1" for those with a BMI of 30 or greater and "0" for those with a BMI of 29 or lower. Our analysis used SAS procedure SURVEYFREQ for bivariate analysis and the SURVEYLOGISTIC procedure for multivariate analysis. The Taylor Series Linearization Method was employed under these procedures to adjust for sampling effects in the analysis.[27]

Descriptive statistics were generated to examine the bivariate impacts of obesity on the weighted sample by ethnicity and by obesity status across a series of sociodemographic characteristics (age, education, ethnicity, and marital status), risk behaviors (smoking and drinking) and health outcomes (hypertension, high cholesterol, diabetes, arthritis, gout, migraines and peptic ulcers). Multivariate logistic regres-

**Table 1. Weighted estimates of descriptive characteristics of Tongan and Samoan males, California, *N* = 103[a, 24]**

| | Tongan | Samoan | Not Obese | Obese | Total PI |
|---|---|---|---|---|---|
| Age categories | | | | | |
| 18 to 25 yrs | 23.1 | 27.6 | 44.9 | 21.3 | 26.4 |
| 26 to 35 yrs | 20.6 | 14.4 | 12.5 | 17.0 | 16.1 |
| 36 to 45 yrs | 22.5 | 29.9 | 4.3 | 34.3 | 27.9 |
| 46 to 55 yrs | 7.5 | 12.4 | 3.9 | 13.0 | 11.1 |
| 56 to 65 yrs | 13.2 | 12.4 | 8.6 | 13.7 | 12.6 |
| > 66 yrs | 13.2 | 3.4 | 25.8 | .6 | 6.0 |
| Marital status | | | | | |
| Currently married | 61.0 | 58.5 | 44.1 | 63.2 | 59.1 |
| Widowed | 5.6 | 1.1 | 11.0 | 0 | 2.3 |
| Divorced | 0 | 1.1 | 0 | 1.1 | .8 |
| Separated | 0 | 2.4 | 0 | 2.2 | 1.8 |
| Never married | 33.4 | 36.9 | 44.9 | 33.5 | 35.9 |
| Completed education | | | | | |
| <High school | 21.4 | 10.7 | 36.6 | 7.3 | 13.6 |
| High school graduate | 56.3 | 52.0 | 36.2 | 57.8 | 53.2 |
| At least some college | 17.0 | 19.7 | 21.0 | 18.4 | 18.9 |
| Some graduate school | 3.4 | 4.7 | 0 | 5.5 | 4.3 |
| Associates degree | 0 | 1.1 | 3.9 | 0 | .8 |
| Vocational, business or trade school | 1.9 | 11.9 | 2.4 | 11.0 | 9.2 |
| Weighted sample size (males aged ≥ 18 years) | 6,521 | 17,740 | 6,521 | 17,740 | 24,261 |

Data are % unless specified otherwise.
PI, Pacific Islander.
a. Unweighted sample size.

sion was used to examine the risk of adverse health effects being associated with the presence of long-standing obesity among Samoan and Tongan males in California.

## Results

Tables 1 through 3 provides weighted descriptive characteristics of the sample of Samoan and Tongan male participants by obesity status. In terms of age distribution and obesity, almost half (47%) of the obese are among midlife males aged 36 to 55 years, while the greatest proportions of the non-obese are bimodal and occur in the youngest age (45%) and the oldest age group (26%), a pattern that has been seen for the United States as a whole.[3] Two-thirds of Samoan and Tongan males are currently married and the majority of the sample has at least a high school education. Obese males are the most likely to report graduating high school (58%) while the non-obese are slightly more likely to report a lack of high school completion.

### Anthropometric Variables

Table 2 compares measures of body mass index (BMI) for the respondents at two points in time; BMI at aged 18 years and current BMI obtained at the time of the interview. Overall, the participants reflect extremely high rates of overall obesity with a striking 84% of Samoan males being obese and 65% of Tongan males compared with the obesity rate of 36% currently estimated for the US adult male population.[3]

**Table 2. Comparison of BMI levels among Tongan and Samoan men at aged 18 years and as of PIHS interview, California, *N*=103[a, 24]**

| | BMI at aged 18 years | | | Current BMI | | |
|---|---|---|---|---|---|---|
| BMI Category | Tongan | Samoan | Total | Tongan | Samoan | Total |
| Underweight | 11.6 | 10.6 | 10.9 | 0 | 0 | 0 |
| Normal weight | 20.4 | 23.5 | 22.7 | 7.2 | 1.1 | 2.8 |
| Overweight | 43.5 | 41.2 | 41.8 | 27.5 | 15.3 | 18.6 |
| Obese | 21.9 | 20.5 | 20.8 | 53.9 | 43.6 | 46.4 |
| Morbid obesity | 2.6 | 4.2 | 3.8 | 11.3 | 40.0 | 32.3 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Weighted sample size (males aged ≥ 18 years) | 6,521 | 17,740 | 24,261 | 6,521 | 17,740 | 24,261 |

Data are % unless specified otherwise.
a. Unweighted sample size.

**Table 3. Weighted estimates of self-reported health characteristics of Tongan and Samoan Males, California, *N* = 103[a,24]**

| | Tongan | Samoan | Not Obese | Obese | Total PI |
|---|---|---|---|---|---|
| Risk behaviors | | | | | |
| Currently smokes | 49.2 | 54.6 | 49.0 | 47.5 | 47.7 |
| Currently drinks | 75.5 | 46.6 | 46.9 | 56.4 | 54.4 |
| Self-reported health conditions | | | | | |
| Hypertension | 16.3 | 32.0 | 25.4 | 28.4 | 27.8 |
| High cholesterol | 17.8 | 23.2 | 21.1 | 22.0 | 21.8 |
| Diabetes | 9.7 | 12.8 | 14.8 | 11.2 | 12.0 |
| Arthritis | 7.5 | 13.9 | 20.2 | 10.1 | 12.2 |
| Gout | 11.0 | 11.7 | 12.5 | 11.2 | 11.5 |
| Migraine headaches | 9.4 | 21.7 | 23.5 | 17.0 | 18.4 |
| Peptic ulcers | 3.8 | 11.8 | 4.7 | 11.0 | 9.7 |
| Weighted sample size (males aged ≥ 18 years) | 6,521 | 17,740 | 6,521 | 17,740 | 24,261 |

Data are % unless specified otherwise.
PI, Pacific Islander.
a. Unweighted sample size.

Consistent with the literature that suggests obesity is a long-term condition among Pacific Islanders, it can be seen that the majority of the adult male sample was already overweight by aged 18 years (44% of Tongans and 41% of Samoans) and 25% of the youth were already obese or morbidly obese by aged 18 years with respondents reporting significant increases in BMI by the time of the interview. As of 2012, no one in the sample was underweight even though 11% of the overall sample had been underweight at aged 18 years and only 7% of Tongan males and 1% of Samoan males had a current BMI that fell within the normal weight designation.

The proportion of Pacific Islander males who were overweight increased significantly over time with only 28% of Tongan and 15% of Samoan males having a BMI in the overweight range while 54% of Tongans and 44% of Samoan males were now obese. While only 3% of Tongan men were morbidly obese at aged 18 years, this proportion increased to 11% by the time of interview. Among Samoan men, this transition was even more striking with a major increase in morbid obesity from only 4% of the sample at aged 18 years to 40% of Samoan men as of 2012. These findings show that the risk of being overweight and obese among Samoan and Tongan men starts early and grows worse across time with major increases in the morbidly obese population after the age of 18.

## Risk Behavior and Health Outcome Variables

Table 3 summarizes risk behaviors and health outcomes commonly associated with the negative impacts of obesity. Both Samoan (55%) and Tongan (49%) males smoke at rates much higher than US males, currently reported as approximately 18% of the adult population aged ≥18 years.[28] Tongan males drink at rates similar to US males, with 76% of Tongan males reporting drinking in the past year compared with 71% of US males overall while Samoan men reported much lower rates (47%) of alcohol consumption.[29]

The presence of hypertension would be expected to be high among Pacific Islander men due to the high rate of obesity, but the results are consistent with rates of 29% seen for US males aged ≥18 years.[30] Similarly, the proportion (22%) of self-reported elevated levels of cholesterol among Pacific Islander males is lower than the US average for adult males estimated at 33%.[31] The proportion (12%) of Pacific Islander males reporting diabetes is markedly higher than the 7% occurrence reported for the US adult males.[32] Among non-obese males, 15% reported having diabetes while 11% of the obese males also reported this condition. The findings are consistent with an established literature that notes high rates of diabetes found among Pacific Islanders, both in the United States and overseas. [33-36]

The increased risk of arthritis and gout are also frequently identified as being associated with obesity. While the prevalence of gout among US adult males is estimated at 6%,[37] Tongans and Samoans report this disease at double this rate (11% and 12%) with similar high levels seen among the non-obese and obese Pacific Islander men (13% and 11%). Approximately 19% of US adult males report doctor diagnosed arthritis,[38] which matches the rate seen for our non-obese sample at 20% while only 10% of the obese sample reported this condition. Obesity is also associated with an increased risk of migraine headaches,[16] which routinely impact about 6% of US males.[39] Obese Pacif-

ic Islander males report high migraine rates at 17%, but the non-obese report the highest overall frequency of 24%. The association between the risk of ulcers and obesity[40] is consistent with the US results where 11% of obese Pacific Islander males reported having or having had ulcers compared to only 5% of the non-obese sample.

## Multivariate Analysis

As more than three quarters of our sample was obese and the bivariate analysis found only limited differences between health outcomes for the obese and non-obese respondents, we employed a bivariate logistic regression model to more precisely measure differences for our dependent variable of obesity (Table 4). Model 1 presents the full model controlling for select sociodemographic characteristics, risk behaviors and specific health outcomes. The sociodemographic variables are all significant ($P$<.05 or greater) with the exception of being never married, which is significant only to $P$<.10. Controlling for other characteristics, each 10-year increase in the age of the respondent corresponds to a 5% increase in the likelihood of being obese.

Education was positively associated with obesity, with men who had not completed high school being 90% less likely to be obese when compared with those with a high school diploma or more. Being currently married had a strong positive effect on the likelihood of being obese, making male respondents more than 10 times more likely to be obese than the post-married reference group. Never being married was also a powerful, though less significant, predictor of the risk of being obese, making non-married male respondents six times more likely to be obese. As expected, Samoan males had a much higher risk (six times more likely) to be obese compared with Tongan males. These sociodemographic results remain stable across all six models so the subsequent analysis focused on the association of risk behaviors and health outcomes with the risk of obesity.

Among risk behaviors, being a current smoker and a current drinker increased the likelihood of being obese more than three times for smokers and two times for drinkers, with smoking representing a significant finding in excess of $P$<.05. In contrast, the health outcome measures offer little support for the assumption of increased risk due to obesity.

**Table 4. Odds ratios for associations between obesity and self-reported health outcomes among Tongan and Samoan men, California, $N$ = 103[a, 24]**

| Characteristics | Model 1 | | | Model 2 | | | Model 3 | | | Model 4 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Odds Ratio | Lower 95 | Upper 95 | Odds Ratio | Lower 95 | Upper 95 | Odds Ratio | Lower 95 | Upper 95 | Odds Ratio | Lower 95 | Upper 95 |
| 10-year age groups | 1.05 | 1.00 | 1.11 | 1.05 | 1.00 | 1.11 | 1.04 | .98 | 1.10 | 1.03 | .98 | 1.08 |
| <High school education | .10 | .02 | .44 | .11 | .03 | .43 | .11 | .02 | .54 | .11 | .03 | .47 |
| Currently married | 10.56 | 2.41 | 46.21 | 9.84 | 1.92 | 50.53 | 7.55 | 1.33 | 43.02 | 7.02 | .91 | 53.92 |
| Never married | 6.00 | .87 | 41.20 | 5.13 | .68 | 38.79 | 4.00 | .56 | 28.84 | 2.93 | .49 | 17.47 |
| Samoan | 6.21 | 2.10 | 18.40 | 6.28 | 2.10 | 18.80 | 6.02 | 2.10 | 17.23 | 5.84 | 1.96 | 17.38 |
| Current smoker | 3.64 | 1.12 | 11.89 | | | | | | | | | |
| Current drinker | 2.05 | .46 | 9.22 | | | | | | | | | |
| Hypertension | 1.02 | .21 | 4.91 | 1.07 | .22 | 5.23 | | | | | | |
| High cholesterol | .52 | .10 | 2.73 | .47 | .10 | 2.15 | | | | | | |
| Diabetes | .40 | .14 | 1.17 | .39 | .13 | 1.13 | | | | | | |
| Migraine headaches | .57 | .10 | 3.18 | .21 | .03 | 1.60 | | | | | | |
| Arthritis | .21 | .03 | 1.70 | 3.54 | .14 | 90.50 | | | | | | |
| Gout | 3.57 | .13 | 96.97 | .56 | .10 | 3.06 | | | | | | |
| Ulcers | 1.48 | .12 | 17.95 | 1.51 | .12 | 19.17 | | | | | | |
| Count of risk behaviors | | | | 2.57 | 1.11 | 5.99 | 2.62 | 1.13 | 6.07 | 2.52 | 1.19 | 5.32 |
| Negative disease counts | | | | | | | .43 | .20 | .94 | | | |
| Positive disease counts | | | | | | | 1.43 | .42 | 4.85 | | | |
| Total disease counts | | | | | | | | | | .72 | .52 | 1.00 |

a. Unweighted estimates based on the logistic regression model.

While the likelihood of being obese was increased if the respondent had hypertension (2% higher), gout (four times higher) and peptic ulcers (48% higher), none of these results were statistically significant. In fact, four of the health outcomes commonly associated with obesity, decreased the likelihood of the respondent being obese: high cholesterol (48% less likely), diabetes (60% less likely), migraines (43% less likely) and arthritis (79% less likely). Diabetes was marginally significant and the directions of the findings were consistent with the pattern seen in the bivariate analysis with few marked differences between the obese and non-obese.

Model 2 summarizes the risk behaviors into a single interval variable that counts the number of risk behaviors the respondent engaged in from 0 to 2 activities, measuring the cumulative impact of smoking and drinking. The summary measure of risk was positive showing the odds of being obese increased 2.6 times with the addition of each risk behavior. This finding is statistically significant and reflects a relatively narrow confidence interval. The association of the risk of obesity and specific health measures remained largely unchanged in direction and magnitude. Obesity remained negatively associated with the risk of having diabetes, while the remaining variables lacked statistical significance and presented the same wide confidence intervals seen in Model 1.

In Model 3, two summary measures are introduced to replace the health outcome variables. Negative Disease Counts had a range of 0-4 and enumerates the total number of health outcomes (high cholesterol, diabetes, migraines, and arthritis) that are negatively associated with the likelihood of being obese. Positive Disease Counts had a range of 0-3 and enumerated the total number of health outcomes (high blood pressure, gout and ulcers) that are positively associated with the likelihood of being obese. In Model 3, Negative Disease Counts remained negatively associated with the likelihood of being obese and is statistically significant, suggesting the risk of obesity is decreased more than 50% in the presence of each additional health concern. Positive Disease Counts remained positively associated with the likelihood of being obese though it is not statistically significant, suggesting an increased risk of obesity of about 43% with each additional reported health outcome.

*…our results suggest that the overall health of Samoan and Tongan males in California is uniformly poor and obesity by itself does not stratify the population in a meaningful manner.*

Model 4 simplifies the measurement of health outcomes to a single health measure, Total Disease Counts that summarized the total number of health outcomes reported by the respondent, ranging from 0-7. The use of disease counts has been shown to be a robust mechanism for looking at health outcomes.[41,42] In Model 4, Total Disease Counts appears to accurately summarize the patterns across the bivariate and multivariate analyses. The summary variable suggests that there is no measurable relationship between health outcomes, commonly associated with the risks of obesity. This measure suggests that the risk of obesity among Pacific Islander males decreased by approximately 30% with each additional health condition. This finding is both statistically significant *(P*<.05) and the confidence intervals of the variable remain in the range of decreased risk.

## Study Limitations

Our study has clear limitations that need to be kept in mind when reviewing the results. The sample measures only the behaviors of Samoan and Tongan males and the results cannot be generalized to other Pacific Islander populations such as Native Hawaiians, Fijians, or Guamanians/Chamorro populations. As Pacific Islanders represent a diverse population that encompass multiple languages and cultural behaviors, it is important not to generalize these findings, but to recognize the need for ongoing work to measure differences due to the internal heterogeneity within this broad racial classification. Another limitation is the relatively small case size of the analysis sample. While representative of Samoan and Tongan males in the state of California, the sample of 103 cases places significant limitations on the complexity of the models we can employ and some of the stronger non-significant findings might

gain significance with more cases. Follow-up studies planned for the PIHS will help address this issue but, at present, our models must be conservative due to the sample restrictions.

## Discussion

Our analysis finds that health conditions commonly associated with obesity are, in fact, more likely to be found among the non-obese population of our Pacific Islander males. Far from implying that obesity may have a protective function within this poorly understood and understudied population, our results suggest that the overall health of Samoan and Tongan males in California is uniformly poor and obesity by itself does not stratify the population in a meaningful manner. The marked differences between Samoan and Tongan males also suggest this is not a "genetic predisposition" for obesity and ill health among Pacific Islanders, but a complex mixture of environment, social norms and community interaction. "Place matters" as a growing number of biomedical and social scientists have argued in public health research. Considerable work will be required to disentangle the complex relationship between health and vulnerable populations such as Pacific Islanders. It is evident from our analysis, however, that there is no clear-cut relationship between obesity and negative health outcomes among Samoan and Tongan males, but with studies such as the PIHS, research tools are emerging that will help better understand the life course and health among US Pacific Islanders.

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