# Age of Onset of Obesity, Diabetes and Hypertension in Yap State, Federated States of Micronesia

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*Abstract*

*Background: As in many areas of the world, obesity, non-insulin dependent diabetes mellitus and hypertension have become major problems in Yap. Methods: The population of the main island cluster of Yap age 2 years and older was surveyed and clinically evaluated. Results: Obesity becomes common in people ages 15-25 years, diabetes (random blood sugar 144) at ages 45-55 years, in females and 55-65 years in males, and hypertension (SBP>140 or DBP>90) at ages 25-35 years. Conclusions: Female and male children might be targeted for obesity prevention as young as 15 years of age and tested for hypertension at 20 years and diabetes at 40 years. (PHD 2007 Vol 14 No 1 pp 165-169)*

## Background

Obesity, non-insulin dependent diabetes mellitus and hypertension cause morbidity and mortality around the world. These diseases are often interwoven.

In a subsistence economy obesity is nearly nonexistent. The transition from subsistence living to processed foods, however, results in a higher prevalence of obesity. Along with obesity comes a higher prevalence of diabetes and hypertension. These modern epidemics cause suffering due to amputations and increased risk of blindness, stroke, nerve damage, kidney disease, and heart attacks.

Worldwide prevalence of diabetes, hypertension, and obesity have dramatically increased in the past few decades. The World Health Organization (WHO) found the four leading causes of mortality in the Federated States of Micronesia (FSM) to be diseases of the circulatory system, neoplasm, diseases of the respiratory system, and endocrine, nutritional, and metabolic diseases, respectively.[1]

The five leading causes of mortality in Yap are heart disease, pneumonia, cancer, stroke, and diabetes, respectively.[2] Of the five leading causes, heart disease, stroke, and diabetes are directly related to obesity; hypertension, diabetes, pneumonia and cancer may sometimes be associated with obesity.

Dr. James V. Neel noted that American Indians, Pacific Islanders and Esquimaux (Eskimos) are seemingly more susceptible to obesity and diabetes than other ethnic groups. He proposed that the cycle of feast and famine that hunter-gatherers and subsistence farmers experienced caused evolution to favor body types that could easily convert sugar and carbohydrates to fat,[3] this is known as the "thrifty gene" hypothesis. In times of plenty, people would eat much more than was healthy to build up fat for times of want. With modernization and the cash economy, enough cheap foods high in salt, sugar and fat are available, that the subsistence economy and cycles of feast and famine are becoming rare, while sedentary lifestyles are becoming the norm.

Easily acquired, pre-packaged foods now dominate the diets of most Yapese. New staples of canned fish and meat (mackerel, spam, and corned beef) and white rice have replaced traditional taro and fresh fish. On average, 41% of household income is spent on imported food, alcohol, and tobacco.[4]

In 2005 grant funding was secured to establish a network of primary care centers in the main island cluster of Yap State. As part of this project, 11 community health workers were trained to provide preventative services to the villages and households of their respective communities. A house-to-house survey was designed to familiarize the health workers with the households in their districts, to identify opportunity for improvement, and to find cases of diabetes, pregnancy, malnutrition, hypertension, tuberculosis, leprosy, and other conditions. Each health center surveyed the geographical area that they were responsible for. All of the households were visited and all residents were surveyed. This data source was used to determine the prevalence of overweight, obesity, and hypertension to determine the age of

onset of these conditions. This information is useful for deciding how to target interventions and measuring their success over time.

## Methods

A cross-sectional household survey conducted between April and August of 2006 was used to gather raw data. The survey was designed and pilot tested in 2005, and then revised to its present form in the Yapese language. Community health outreach workers were trained to administer the survey and to deliver other preventative services through six college level courses administered through the College of Micronesia. These courses included in-depth training in traditionally appropriate means of approaching local communities, establishing rapport with survey respondents and taking measurements. The study was directed toward all of the residents of one of the main districts of Yap, Nimigil. Height and weight were recorded for all ages, blood pressure for people age ≥15 years and random capillary glucose for people age ≥35 years because substantial rates of hypertension and diabetes were thought to be unlikely in younger age groups.

Random blood sugar was measured using a capillary blood glucose meter using standard procedure as described in the meter's package insert.[5] Glucose measurements were taken without regard to meal times. Subjects were also asked, "Has a doctor or health worker ever told you that you have high blood sugar or diabetes?" Random blood sugar of >144 or self-professed diabetes identified a person as diabetic.[6] Height was measured in inches in a standing position using a rigid measuring stick. Bed bound subjects were measured in supine position. Weight was measured in pounds using a portable spring scale calibrated with 50- and 100- pound reference weights. Shoes and excess garments were removed when subjects were weighed, but lightweight garments were left in place.

Blood pressure was measured on adults with an arm cuff sphygmomanometer with a dial pressure gauge. Hypertension was defined as a systolic blood pressure of >140 or a diastolic blood pressure >90.[7] The target group was subdivided into age groups as follows: >2-5 yrs; 5.1-10 yrs; 10.1-15 yrs; 15.1-25 yrs; 25.1-35 yrs; 35.1-45 yrs; 45.1-55 yrs; 55.1-65 yrs; 65.1-75 yrs; and >75 yrs; The age groups were further stratified by sex.

Epi Info™ was used to convert weight in pounds to weight in kilograms, height in inches to height in meters, and to calculate body mass index (BMI) (kg/$m^2$). Adults were defined as people over the age of 15 years and children as people aged 2 through 15. For adults, overweight was defined as a BMI of 25 to 29.9, and obesity was recorded as a BIM of 30 or greater as defined by the U.S. National Institutes of Health's National Heart, Lung, and Blood Institute. For children, overweight and obesity were defined as BMIs > 85% and 95% of the reference population[8] by age and sex.[9] Epi Info was used to calculate the prevalence of obesity, overweight, hypertension, and diabetes, stratified by age groups and sex. Non-respondents were excluded from the prevalence calculations.

## Results

There were 3,496 adult participants in this study. The response rate for this study was 71% of the population of Yap Proper compared to the 2000 census. Female adults (1869, 53%) outnumbered male adults (1627, 47%). There were 1736 child participants in this study. Male children (888, 51%) outnumbered female children (848, 49%) (Tables 1 and 2).

**Table 1. Characteristics of the Adult Population Sample**

| | |
|---|---|
| **Population** | 3496 |
| Male adults | 1627 (47%) |
| Female adults | 1869 (53%) |
| **Age in years** | |
| >15 - 25 | 884 (25%) |
| >25 - 35 | 693 (20%) |
| >35 - 45 | 642 (18%) |
| >45 - 55 | 664 (19%) |
| >55 - 65 | 326 (9%) |
| >65 - 75 | 181 (5%) |
| >75 | 106 (3%) |
| **Obese** (BMI ≥30) | 1264 (36%) |
| **Overweight** (BMI ≥25) | 955 (27%) |
| **Mean BMI** | 28 |
| **Diabetic** (RBS>144) | 696 (20%) |
| **Hypertensive** (SBP>140 or DBP>90) | 1229 (35%) |

The mean BMI for adults was 28. Thirty-seven percent of female adults (696) were obese and 25% (473) were overweight. Thirty-five percent of male adults (568) were obese and 30% 482) were overweight. Female children had an obesity prevalence of 20% (144) and an overweight prevalence of 13% (99). Male children had an obesity prevalence of 21% (164) and an overweight prevalence of 10% (78) (Table 3).

**Table 2. Characteristics of the Child Population Sample**

| | |
|---|---|
| **Population** | 1736 |
| Male children | 888 (51%) |
| Female children | 848 (49%) |
| **Age in years** | |
| 2 - 5 | 359 (23%) |
| >5 - 10 | 584 (38%) |
| >10 - 15 | 588 (38%) |
| **Overweight** (85-95% reference population) | 177 (12%) |
| **Obese** (95% reference population) | 243 (16%) |

The overall prevalence of obesity was 36% (1264) for adults and 16% (243) for children. The overall prevalence of overweight adults was 27% (955) and 12% children (177). In both males and females, the prevalence of obesity and overweight were remarkably high. The prevalence of obesity started to rise steeply at 15 years of age for both males and females. Prevalence of obesity peaked between the ages of 55 and 65 years for males and between the ages of 45 and 55 years for females. Although the prevalence of obesity or overweight rose sharply in both males and females, females had a higher rate (Figures 1 and 2).

The overall prevalence of hypertension in adults was 35% (1229). The prevalence of hypertension for males was overall much higher than the prevalence for females. Males experienced a notable rise in prevalence at a slightly older age than females did. While males experience dramatic changes in prevalence across the age groups, females had relatively little change. The prevalence of hypertension in males peaked between age 55 and 65. The hypertension in females had a maximum at 75 years of age (Table 3).

The total population over the age of 35 had a diabetes prevalence of 20% (696). Females had a diabetes prevalence of 19% (349) while males had 21% (347). Males had a definite upsurge of prevalence at age 55 while females increased steadily. Males generally had higher rates of prevalence than did females. The prevalence of diabetes in females increased steadily from age 35 to 55, and then decreased steadily after ages >75.

In both females and males, the prevalences of obesity, overweight, hypertension, and hyperglycemia took upswings between the ages of 25 and 55. Males generally had higher prevalences than females, except occasionally before the age of 45.

Of the 696 subjects with diabetes, 71% (496) reported never having been informed that they were diabetic.

## Discussion

This is the first systematic, population-level study of these conditions in Yap. The population of Yap Island has significant burdens of obesity and overweight, hypertension, and diabetes. Obesity and overweight appear in children as young as 2 years of age and skyrocket between ages 15 and 25 years in both males

**Table 3. Prevalence of Obesity, Overweight, Elevated Blood Pressure, and Diabetes by Age Group**

| | Obesity # (%) | | | Overweight # (%) | | | Hypertension # (%) | | | Diabetes # (%) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age Group (Yrs) | Males | Females | Both | Males | Females | Both | Males | Females | Both | Males | Females | Both |
| >2-5 | 51 (27) | 37 (22) | 88 (25) | 11 (6) | 10 (6) | 5 (6) | | | | | | |
| >5-10 | 56 (19) | 54 (19) | 110 (19) | 35 (12) | 54 (19) | 89 (15) | | | | | | |
| >10-15 | 57 (19) | 53 (19) | 110 (19) | 32 (11) | 56 (20) | 88 (15) | | | | | | |
| >15-25 | 82 (18) | 118 (24) | 200 (23) | 119 (26) | 116 (23) | 235 (27) | 121 (26) | 79 (16) | 200 (23) | 41 (9) | 40 (8) | 81 (9) |
| >25-35 | 125 (41) | 157 (42) | 282 (41) | 93 (30) | 98 (27) | 191 (28) | 130 (42) | 83 (22) | 213 (31) | 36 (12) | 49 (13) | 85 (12) |
| >35-45 | 123 (46) | 167 (47) | 290 (45) | 88 (33) | 92 (26) | 180 (28) | 109 (41) | 80 (23) | 189 (29) | 75 (28) | 52 (15) | 127 (20) |
| >45-55 | 151 (48) | 151 (44) | 302 (45) | 98 (31) | 95 (28) | 193 (29) | 172 (54) | 137 (39) | 309 (47) | 94 (30) | 102 (30) | 196 (30) |
| >55-65 | 62 (41) | 66 (45) | 128 (39) | 50 (33) | 37 (25) | 87 (27) | 85 (56) | 71 (49) | 156 (48) | 53 (35) | 56 (38) | 109 (33) |
| >65-75 | 19 (24) | 33 (31) | 52 (29) | 28 (35) | 25 (24) | 53 (29) | 52 (66) | 60 (57) | 112 (62) | 34 (43) | 36 (34) | 70 (39) |
| >75 | 6 (17) | 4 (8) | 10 (9) | 6 (17) | 10 (19) | 16 (15) | 22 (63) | 28 (54) | 50 (47) | 14 (40) | 14 (27) | 28 (26) |

and females. Following the development of obesity, both males and females begin to experience hypertension and diabetes within 10 years.

On Yap, obesity, overweight, elevated blood pressure, and diabetes were virtually unknown prior to 1960.[2] It is likely that as economy and level of development continue to change these diseases will become more prevalent. To understand the changes in patterns this is a useful study for comparison with future findings.

Although not much is known about effectiveness of interventions at community level for prevention and control of obesity, especially in developing country settings, this study has implications for policy. Female and male children as young as two years old might be targeted for obesity prevention. Cutoffs of 15 years old for hypertension and 35 years old for diabetes testing were chosen because substantial rates of hypertension and diabetes were thought to be unlikely in younger age groups. Testing, however, might begin at age 15 in both males and females for hypertension, and younger than 35 for diabetes since there is a considerable prevalence of hypertension in the 15.1-25-year age group and diabetes in the 35.1-45-year age group.

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Community-wide campaigns for exercise programs and dietary changes and personalized lifestyle counseling are strongly recommended by the Guide to Community Preventive Services. The U.S. Task Force on Community Preventative Services suggests non-family social support such as exercise groups and sponsored walks, informational outreach activities, plus the creation and maintenance of places for physical activities,[10] although the effectiveness of these strategies in developing country settings are unknown.

The use of Wellness Centers to deliver anticipatory guidance can be useful in preventing these non-communicable diseases, although this approach would have to be tested in Yap. Physical education in school and well-maintained sports facilities can also help combat obesity. This study found Yap to have a colossal burden of obesity. TV is associated with obesity and so far the residents of Yap do not have easy access to television and cable service. This study provides further reason to preserve Yap's traditions and block the setup of a local TV station.

For obesity prevention, some measures should be administered to children as young as preschool, perhaps through promotion of breastfeeding and local foods. Particular attention should be focused on people aged 15-25, because these people are the most vulnerable to developing obesity according to the results of this study.

Obesity on Kosrae, Pohnpei, and Chuuk is now 2.5 to 3 times the prevalence of that in the U.S.[4] Studies on other Pacific Islander populations demonstrate the same affect of lifestyle on disease prevalence. Residents of the island of Tuvalu who live in the city have over double the prevalence of diabetes than rural Tuvaluans. Samoans in Hawai'i and California have a very high prevalence of obesity.

Other states in the FSM have higher rates of obesity than Yap, perhaps because the Yapese are more traditional. A recent study on the island of Kosrae in the FSM found the average BMI to be 31, compared with the Yap average of 28.7. Thirty-five percent of the entire Kosrae population had a BMI between 30 and 34. Furthermore, 12% of adults older than 20 years were diabetic. A significant increased risk of diabetes with increasing age was noted, with individuals older than 50 years having 35 times the risk of diabetes as individuals 20-34 years of age.[4]

There are several limitations of this study. Unsophisticated instruments could have contributed to measurement error that could in turn have affected findings. There are several potential problems with regard to validity.

The instruments used by surveyors to measure height, weight, blood pressure, and blood sugar were not the most sophisticated, precise tools that most prominent laboratories utilize. The spring scales that were used may be more accurate at middle weights, than at higher and lower weights. The accuracy of determinations of blood pressure and glucose by use of an arm cuff sphygmomanometer, and glucose meter are somewhat dependent upon technique, though efforts were made to control this source of error by thoroughly training and certifying proficiency for surveyors.

The study had several non-respondents, but there is no indication that they would exhibit different distributions of non-communicable diseases than those who participated. Blood sugar was measured once with a single random capillary blood test. People with impaired glucose metabolism may have normal blood glucoses on a single, random sample. On the other hand, people with normal glucose metabolism may occasionally

have heightened blood glucose readings higher than the cutoff used in this study, especially after a large dietary glucose load. This study's use of a random blood capillary glucose test with a cutoff of 144 mg/dl has a sensitivity of 69 and a specificity of 95%. A more specific method would be a fasting blood sugar of greater than or equal to 126 or a 2-hour oral glucose tolerance test greater than or equal to 200. Diabetics were asked to identify themselves, which may be a source of bias. Previous studies on validity, however, indicate that self-reports of diabetes are accurate.[11]

The use of a single blood pressure measurement may misclassify elevated blood pressure, since blood pressures fluctuate and people with normal blood pressure may temporarily have elevated blood pressures. In addition, people with normal blood pressure readings were not asked if they were hypertensive. Some of these may have been on medication with normal blood pressures at the time of survey and been misclassified as non-hypertensive.

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In regard to BMI, there is some controversy regarding the appropriate BMI cutoffs for obesity and overweight in various ethnic groups. It appears that due to differences of body build, some Asian ethnic groups experience the adverse health effects of obesity at lower levels of BMI than Europeans. The use of the higher standard BMI cutoffs for such groups would underestimate the proportions of Asian populations at risk.[12] Micronesians, however, have not been studied specifically in this regard, therefore the WHO recommended BMI cutoffs of 25 and 30 were used in this study.

This study was performed to determine age of onset, but the cross-sectional study cannot infer age of onset with complete confidence. It is possible that recent environmental factors may have affected certain age groups more than others which would give the same appearance as a chronic condition that began early in life (i.e., a "cohort effect"). However, no such environmental factors exhibiting this effect have been observed for these conditions.

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