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Epidemiology of areca (betel) nut use in the Mariana Islands: Findings from the University of Guam/University of Hawai`i Cancer Center Partnership Program

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Abstract

Background—Areca (betel) nut is considered a Group 1 human carcinogen shown to be associated with other chronic diseases in addition to cancer. This paper describes the areca (betel) nut chewing trend in Guam, and health behaviors of chewers in Guam and Saipan.

Methods—The areca (betel) nut module in the Guam Behavioral Risk Factor Surveillance Survey was used to calculate the 5-year (2011-2015) chewing trend. To assess the association between areca (betel) nut chewing and health risks in the Mariana Islands, a cross-section of 300

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Contributions: YCP advocated for the inclusion of the betel nut module in the Guam BRFSS, conceived of the betel nut and health risk study, led the implementation of the study in Guam and Saipan, and developed the initial manuscript draft. ELH participated in the study design, coordination, and statistical analysis, and helped edit the manuscript. JCO collected the data in the CNMI and helped draft and edit the manuscript. TCP contributed to the literature review and statistical analysis, and helped draft and edit the manuscript. ABY contributed to the literature review, and helped draft and edit the manuscript. RN contributed to the initial acquisition of funding and study design and provided critical review of the manuscript. LRW consulted on the design and conduct of the study and provided critical review of the manuscript. MJM contributed to the initial acquisition of funding and study design, and edited the manuscript. NAP contributed to the design and conduct of the study, and helped draft and edit the manuscript.

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chewers, 18 years old, were recruited from households in Guam and Saipan. Self-reported sociodemographics, oral health behaviors, chronic disease status, diet, and physical activity were collected. Anthropometry was measured. Only areca (betel) nut-specific and demographic information were collected from youth chewers in the household.

Results—The 5-year areca (betel) nut chewing prevalence in Guam was 11% and increased among Non-Chamorros, primarily other Micronesians, from 2011 (7%) to 2015 (13%). In the household survey, most adult chewers (46%) preferred areca nut with betel leaf, slaked lime, and tobacco. Most youth chewers (48%) preferred areca nut only. Common adult chronic conditions included diabetes (14%), hypertension (26%), and obesity (58%).

Conclusion—The 5-year areca (betel) nut chewing prevalence in Guam is comparable to the world estimate (10-20%), though rising among Non-Chamorros. Adult and youth chewers may be at an increased risk for oral cancer. Adult chewers have an increased risk of other chronic health conditions. Cancer prevention and intervention strategies should incorporate all aspects of health.

Keywords

Alcohol; areca; betel; BRFSS; Commonwealth of the Northern Mariana Islands; chronic disease; Guam; Micronesia; obesity; oral cancer; surveillance; tobacco

1 Background

The University of Guam (UOG) and the University of Hawai'i Cancer Center (UHCC) partnership has been supported by funding from the United States (US) National Cancer Institute (NCI) since 2004 to develop cancer research capacity at the UOG and to expand the Pacific Islander cancer health disparities research at the UHCC [1]. Initial work through the partnership resulted in the estimation and dissemination of oral cancer rates in Guam. For example, Haddock [2] reported disparity in mouth cancer incidence rates across racial and ethnic groups. The mouth cancer incidence rates for the period 1997-2003, age-adjusted to the US 2000 standard population per 100,000 people, were (in descending order): 17.9 in Micronesians, 8.1 in Chamorros, 5.4 in Whites, 3.5 in Asians, and 2.2 in Filipinos [2]. In a follow-up paper by Haddock and colleagues, the mortality rates for the period 1998-2002 for cancer of the mouth and pharynx (excluding nasopharynx) per 100,000 people was highest in Chamorros (6.4) and Micronesians (6.3), followed by Caucasians (2.6) [3]. These disparities in oral cancer rates were confirmed in the first Guam Cancer Facts and Figures supported by the UOG/UHCC partnership and published in 2009 [4]. Since the oral cancer incidence and mortality rates were highest among Chamorros and Micronesians in Guam, it was proposed that areca (betel) nut chewing, a behavior practiced by both groups, may partly explain the racial and ethnic disparities in oral cancer [2, 3].

The areca (betel) nut, a food item classified as a Group 1 human carcinogen [5], is chewed by approximately 600 million people worldwide [6]. Once limited to an endemic practice in the peoples of Yap, Palau and the Marianas (Guam and the Commonwealth of the Northern Mariana Islands (CNMI)) in Micronesia, areca (betel) nut chewing has become ubiquitous throughout the Micronesian region as other islands adopted the practice. Chewing patterns have been found to vary among Micronesian populations, from as simple as chewing the

areca nut alone among the Chamorros in Guam to chewing combinations of the areca fruit with *Piper* (betel) leaf, slaked lime, tobacco and spiked with alcohol among other Micronesians in Guam [7].

The estimation of exposure to areca (betel) nut chewing in Micronesia has been limited in the past and largely excluded from the world estimate. Furthermore, the habit has been found to be associated with all-cause mortality [8] and with non-cancer non-communicable diseases, such as cardiovascular disease, diabetes, obesity, and hypertension [8, 9]. The health risks of areca (betel) nut chewing are of particular interest, because non-communicable diseases contribute to the leading causes of death in the Mariana Islands.

The UOG/UHCC partnership has supported a pilot study to examine the feasibility of screening and examination of pre-malignant, malignant, and other health risks among areca (betel) nut chewers in Guam and Saipan. The results of oral potentially malignant disorders from this study have been described elsewhere [10]. The objectives of this paper are to describe the areca (betel) nut chewing trend using national surveillance data in Guam, and to describe the health behaviors of areca (betel) nut chewers from the pilot study in Guam and Saipan.

2 Methods

The UOG/UHCC partnership was established and funded by the NCI to develop research capacity at UOG; develop cancer health disparities research at UHCC focusing on Pacific Islanders; raise awareness of cancer and cancer prevention in Guam, Hawai'i and the US Associated Pacific Islands; and increase the number of cancer and biomedical researchers of Pacific Island ancestry in the US [1]. This paper presents findings from two projects, the surveillance project and the areca (betel) nut chewers' health project, supported by the partnership.

The surveillance project sought to document the areca (betel) nut chewing patterns and estimate use in Guam. The partnership worked with the Guam Department of Public Health and Social Services to reestablish areca (betel) nut use module, used in 1991, into the 2007 Guam Behavioral Risk Factor Surveillance System (BRFSS), a national health survey administered by the Centers for Disease Control and Prevention (CDC). The module was modified in 2007 to capture the maturity and variety of the areca nut, addition of other ingredients, spiking with alcohol, and the practice of ingesting or discarding the betel quid – the combination of the nut with other ingredients. The module has been active in the Guam BRFSS surveys since that time, although with modifications over the years. Recruitment into the BRFSS is through a complex sampling method described elsewhere [11]. A random sample of Guam residents are called on the telephone and asked questions on a range of health indicators. The sampling methodology changed in 2011 to capture both landline and mobile phone users. The areca (betel) nut chewing prevalence reported in this paper reflects the 5-year trend from 2011 to 2015. The BRFSS was conducted in the CNMI only in 2009, so trend data on areca (betel) nut chewing in the CNMI are unavailable.

The areca (betel) nut chewers' health project sought to perform an oral screening and health assessment among 300 areca (betel) nut chewers, 18 years of age, in Guam (n=137) and Saipan (n=163) from January 2011 to June 2012. Recruitment details are described elsewhere [10]. Up to three adult chewers were selected from a household and completed the full survey assessment. Selected areca (betel) nut behaviors and demographics of household members that chewed at the time of the survey, other than the 1-3 respondents, were provided by the head-of-household to assess the extent of household use, especially among the youth. Two teams, one in each island, were trained to consent participants, administer health questionnaires, and collect anthropometric measures. Approval from the Institutional Review Boards at the University of Hawai'i- M noa (CHS #18174) and the University of Guam (CHRS #10-73) was obtained. All the participants were informed of and consented to the study.

2.1 Questionnaires

A questionnaire on demographics and socioeconomic status, and self-reported medical history, which have been used in a previous local study [12], was administered to all respondents. To validate self-reported chronic conditions, permission was requested from a subset of the participants to contact their primary physician to verify their reports. Of the 49 participants in Guam with self-reported chronic conditions, 11 could not remember their primary physician, some of whom have migrated to Guam in recent years. Self-reports from the remaining 38 participants were sent to the reported primary physician or clinic for verification. The self-report of 11 participants were validated by the physician or clinic and returned to the research team. All the returned self-reported chronic conditions were confirmed. Two additional conditions (hypertension and stroke), not reported by the participant, were reported by the physician or clinic. The median percent agreement between the participants' self-reports and the physicians' confirmation was 89% for all chronic conditions.

Three other questionnaires were administered to all respondents. A validated questionnaire on areca (betel) nut use [13] was simplified to collect information on individual chewing practices. One 24-Hour Dietary Recall was used to collect dietary intake according to the multiple-pass approach [14]. Physical activity over the past 30 days was measured using the Physical Activity Rating Questionnaire [15]. In addition, the Head-of-Household was administered a survey on areca (betel) nut chewing practices and demographics of other household members who were not respondents.

2.2 Anthropometry

The teams were trained on the collection of height, weight, waist, and hip measurements. Height and weight were measured using a stadiometer (Seca, Germany) and a digital scale (ProFit Lifesource, Milpitas, CA), respectively. These measurements were used to categorize participants by Body Mass Index (BMI; calculated as kg/m^2). A tape measure (Seca, Germany) was used to measure hip and waist circumference. A waist-to-hip ratio was used to determine risk of metabolic complications with the cut-point of 0.90 cm for men and 0.85 cm for women [16].

2.3 Analysis

The Guam BRFSS sampling weights were provided by the CDC. The weights were computed similarly to the US state-level weights, which account for sex, age, national race/ethnicity, education, marital status, home ownership, and phone usage [17]. The Guam BRFSS final weights were used to estimate the sex- and ethnic-specific areca (betel) nut chewing prevalences overall, and for each year from 2011 to 2015. Logistic regression was used to test trends across years, where the binary outcome of BN chewing status was regressed on BRFSS years as an ordinal variable.

Data from the areca (betel) nut chewers' health project in Guam and Saipan were analyzed by areca (betel) nut chewing patterns created by latent class analysis (LCA). LCA is a statistical modeling technique that identifies latent variables (groups) based on the relationships among observed categorical data [18]. In this study, the following variables were included in the LCA [10]: smoking and alcohol use, variety and maturity of the areca nut, the addition of betel leaf, slaked lime, tobacco and alcohol, and the ingestion of betel quid. The LCA resulted in the identification of Class 1 (preference for chewing the mature/red areca nut, adding the betel leaf, and swallowing the by-products) and Class 2 (preference for chewing the young/red or white areca nut, adding the betel leaf, slaked lime, and tobacco, and discarding the by-products) chewers. Comparisons were performed between chewing classes using the chi-square test for categorical data and t-test for continuous data, using an alpha of 0.05.

3 Results

In the surveillance project based on Guam BRFSS data, the mean 5-year prevalence of areca (betel) nut chewing in Guam was 11.3%, ranging from 11.2% in 2011 to 12.5% in 2015 as seen in Figure 1. The areca (betel) nut chewing prevalence ranged from 14.0% in 2011 to 15.3% in 2015 among male, while the prevalence ranged from 8.4% in 2011 to 9.6% in 2015 among females. The areca (betel) nut chewing prevalence decreased from 16.6% in 2011 to 13.0% in 2015 within the Chamorro group. Among Non-Chamorros, the areca (betel) nut chewing prevalence almost doubled from 6.6% in 2011 to 12.5% in 2015, and this increase was statistically significant ($p=0.006$).

3.1 Household betel nut (BN) chewing and health risks in Guam and Saipan

From the areca (betel) nut health project in Guam and Saipan, the demographics and chewing preferences are summarized in Table 1. Among the 300 adult areca (betel) nut chewers surveyed, the majority were from Saipan (54%) and were male (52%). The top three chewing preferences were: areca nut with betel leaf, slaked lime, and tobacco (46%); areca nut with slaked lime and tobacco (16%); and areca nut with betel leaf and slaked lime (12%).

Among the 27 youth chewers reported in any household, the majority were from Guam (52%) and were male (56%). The top three chewing preferences were: areca nut only (48%); areca nut with slaked lime and tobacco (33%); and areca nut with betel leaf, slaked lime, and tobacco (11%).

The health characteristics of the 300 areca (betel) nut chewers in Guam and Saipan are summarized in Table 2. The mean age was 38 years. When stratified by chewing pattern, chewers in Class 1 were significantly older than Class 2 (46 versus 35 years, $p<0.001$). Overall, few (7%) pursued education beyond high school, and 33% were married. Among the oral health behaviors, the mean length of areca (betel) nut use was 20 years; longer in Class 1 than in Class 2 (26 versus 18 years, $p<0.001$). The mean number of nuts chewed daily was 13; fewer in Class 1 than in Class 2 (7 versus 15 nuts, $p<0.001$). The mean chewing episode lasted 19 minutes; longer in Class 1 than in Class 2 (38 versus 12 minutes, $p=0.01$). Approximately 30% of the adults chewers visited the dentist regularly; more in Class 1 than in Class 2 (45% versus 24%, $p<0.001$).

Among the chronic diseases, the prevalence among the 300 chewers was 14% for diabetes, 2% for stroke, 3% for heart attack, and 26% for hypertension. There were significantly more areca (betel) nut chewers with hypertension in Class 1 (40%) versus Class 2 (21%) ($p=0.001$). Compared to Class 2, chewers in Class 1 had a higher mean BMI (35 versus 32, $p=0.008$), mean waist-to-hip ratio (0.95 versus 0.92, $p=0.027$), and obesity prevalence (70% versus 54%, $p=0.014$). Among the dietary variables, total dietary energy intake, cups of fruits, ounces of meat and beans, and drinks of alcoholic beverages were similar between the chewing patterns. Compared to Class 2, chewers in Class 1 consumed more kilocalories from discretionary fat (58 versus 45, $p=0.002$), cups of dairy (0.67 versus 0.26, $p<0.001$), cups of vegetables (1.04 versus 0.68, $p<0.001$), and teaspoons of added sugar (16 versus 10, $p=0.001$), and consumed fewer ounces of grain (7 versus 9, $p=0.004$). More chewers in Class 1 (40%) than Class 2 (19%) engaged in regular exercise ($p=0.001$).

4 Discussion and Conclusion

This paper is the first to report on the areca (betel) nut chewing trend in Guam. The 5-year (2011 to 2015) areca (betel) nut chewing prevalence of 11% is comparable to the world estimate of 10-20% [6]. Most striking was the significant increasing trend among other ethnic groups from 7% in 2011 to 13% in 2015. The vast majority of areca (betel) nut chewers in this group were Other Micronesians, including Chuukese, Yapese, Palauan, Pohnpeian, Kosraean, and Marshallese. This may reflect the acculturation of other ethnic groups to the Marianas culture of areca (betel) nut chewing, or the increase in migration to Guam from other islands in Micronesia of islanders who chew areca (betel) nut, or both. The inclusion of questions in future studies that capture migration history will help identify the factors driving the increase in areca (betel) nut chewing among other ethnicities.

Surveillance of areca (betel) nut chewing prevalence via the Guam BRFSS has provided the data needed to support local government and community partnerships in developing health strategic plans. The UOG/UHCC partnership is currently conducting the Betel Nut Intervention Trial to study the effectiveness of a cessation program. If the program proves effective and is launched island-wide, the investigators plan to monitor the impact in Guam through the BRFSS. The trend analysis could not be done for Saipan due to the absence of the CNMI in the annual BRFSS. The only official BRFSS report of areca (betel) nut chewing prevalence in the CNMI was 24% in 2009 [19]. The CNMI has renewed interest in areca (betel) nut chewing surveillance via the BRFSS and recently completed its 2016

hybrid survey. Therefore, the availability of future areca (betel) nut chewing surveillance data in the CNMI seems promising.

The results from the areca (betel) nut chewers' health project in Guam and Saipan have provided additional information on the areca (betel) nut chewing preferences of the adults surveyed and the youth residing in the household. Among adults, the most preferred chewing combination was the areca nut with the betel leaf, slaked lime, and tobacco (46%), although the preference for areca nut only was reported by 12% of the adults. In contrast, the most common preference among the youth was chewing the areca nut only (48%), although some reported a preference for the addition of other ingredients including the betel leaf, slaked lime, and tobacco (44%). If the areca (betel) nut chewers in this study are representative of all the chewers in the Mariana Islands, then the youngest chewer in the island chain is 9 years old. This is the youngest reported in the literature of areca (betel) nut use among youth in Micronesia [20-22] since 1952 when chewers as young as 6 years old were documented in Guam [23]. In 1952, Gerry and colleagues reported that children chewed the areca nut alone in their early years and added the betel leaf as they matured, and that slaked lime and tobacco were used among older users [23]. Today, more than 50 years later, 48% of the youth still chew the areca nut along. However, the preference appears to have evolved among the youth to the addition of other ingredients, including the slaked lime and tobacco. The addition of such ingredients among the youth in this study are consistent with other reports of areca (betel) nut chewing among Micronesian youth [20-22]. Considering the young age at onset of areca (betel) nut chewing and the evolving preference for chewing with tobacco, youth in Micronesia, including those in this study, may be at an increased risk for oral cancer. The adult chewers are also highly susceptible to oral cancer based on their oral health behaviors. The high prevalence of chronic conditions (i.e., diabetes, hypertension, and obesity) and low fruit and vegetable intake further increases the health risks of the adult areca (betel) nut chewers in this study. Cancer prevention and intervention strategies should incorporate all aspects of health.

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Highlights

- Guam 5-year areca (betel) nut chewing prevalence from 2011 to 2015 was 11%
- Rise in prevalence in Non-Chamorros almost doubled from 7% in 2011 to 13% in 2015
- The youngest areca (betel) nut chewer in the household was 9 years old
- Most of the adult chewers (46%) preferred areca nut with leaf, slaked lime, and tobacco
- Most of the youth chewers (48%) preferred areca nut only
- Health risks varied by areca (betel) nut chewing preferences

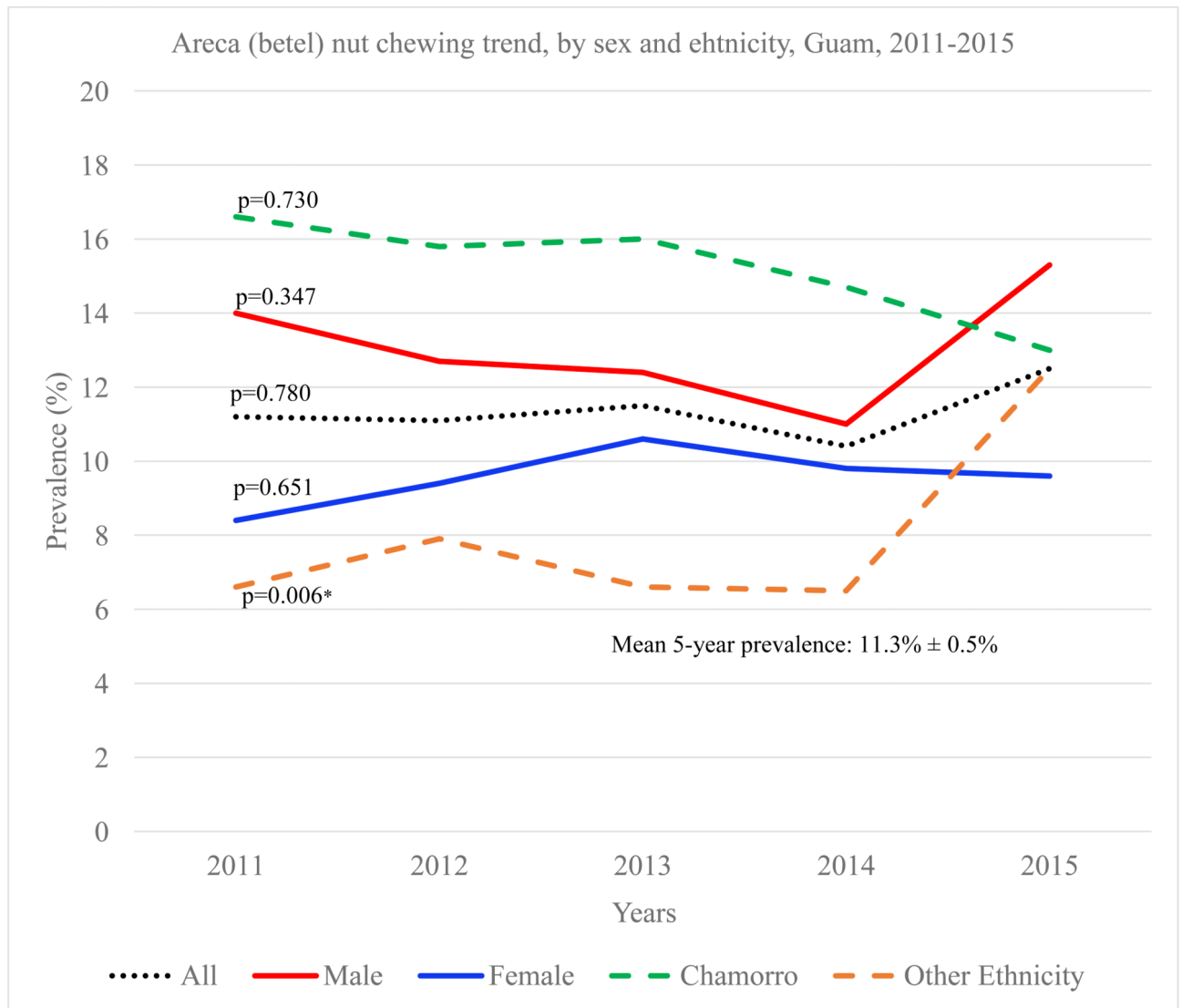


Figure 1. Trend of areca (betel) nut chewing prevalence in Guam from 2011 to 2015, stratified by gender and ethnicity. Data were extracted from the Guam Behavioral Risk Factor Surveillance System. *P* values represent trend over the 5-year period. *Statistically significant at $P < 0.05$.

Table 1
Demographics and chewing preferences of areca (betel) nut chewers in selected households in Guam and Saipan

	Adult ^a areca (betel) nut chewers surveyed (n = 300) n (%)	Youth ^b areca (betel) nut chewers in the household (n = 27) n (%)
Location		
Guam	137 (45.7)	14 (51.9)
Saipan	163 (54.3)	13 (48.1)
Gender		
Males	157 (52.3)	15 (55.6)
Females	143 (47.7)	6 (22.2)
Unknown	0	6 (22.2)
Chewing preferences		
Areca nut only	35 (11.8)	13 (48.1)
With betel leaf	33 (11.0)	0
With slaked lime	1 (0.3)	1 (7.6)
With tobacco	3 (1.0)	0
With betel leaf and slaked lime	37 (12.3)	1 (7.6)
With betel leaf and tobacco	4 (1.3)	0
With slaked lime and tobacco	49 (16.3)	9 (33.3)
With betel leaf, slaked lime, and tobacco	138 (46.0)	3 (11.1)

^aIncludes up to three adult areca (betel) nut chewers, 18-75 years old, surveyed from the household.

^bIncludes all youth, 9-17 years old, reported by the head-of-household to chew areca (betel) nut at the time of the survey.

Table 2

Comparison of health characteristics ((mean [95% Confidence Interval] or n (percent)) between Class 1 and Class 2 areca (betel) nut chewers in Guam and Saipan.

	Overall n = 300 Mean [95% CI] or n (%)	Class 1 n = 78 Mean [95% CI] or n (%)	Class 2 n = 222 Mean [95% CI] or n (%)	P
Demographics				
Age, years *	37.7 [36.2-39.2]	45.7 [42.7-48.6]	34.9 [33.3-36.6]	0.000
% males	157 (52.3)	38 (48.7)	119 (53.6)	0.458
% educated beyond high school	21 (7.0)	3 (3.84)	18 (8.10)	0.202
% married	98 (32.7)	29 (37.2)	69 (31.1)	0.324
Oral health behaviors^a				
Length of areca (betel) nut use, years *	19.8 [19.4-20.1]	25.5 [24.7-26.2]	17.8 [17.4-18.1]	<0.001
Number of nuts chewed per day *	12.8 [11.3-14.2]	7.3 [5.4-9.1]	14.6 [12.8-16.3]	<0.001
Duration of chewing episode, minutes *	18.7 [10.5-26.8]	37.8 [7.5-68.0]	12.0 [9.5-14.4]	0.010
*% visited the dentist	89 (29.7)	35 (44.9)	54 (24.3)	<0.001
Chronic disease				
% diagnosed with diabetes	43 (14.3)	16 (20.5)	27 (12.2)	0.070
% diagnosed with a stroke	5 (1.70)	3 (3.80)	2 (0.90)	0.080
% diagnosed with a heart attack	8 (2.70)	3 (3.80)	5 (2.30)	0.452
% diagnosed with hypertension *	77 (25.7)	31 (39.7)	46 (20.7)	0.001
Anthropometry				
Body mass index *	32.4 [31.5-33.3]	34.5 [32.5-36.4]	31.7 [30.6-32.7]	0.008
Obese *	172 (58.3)	54 (70.1)	118 (54.1)	0.014
Waist-to-hip ratio *	0.93 [0.92-0.94]	0.95 [0.93-0.97]	0.92 [0.91-0.94]	0.027
Diet and physical activity				
Total food energy, kcal	2322 [2196-2446]	2360 [2071-2649]	2307 [2171-2443]	0.713
Energy from discretionary fat, kcal *	48.4 [44.9-51.9]	57.8 [48.8-66.8]	45.1 [41.7-48.6]	0.002
Dairy, cups *	0.36 [0.30-0.43]	0.67 [0.51-0.83]	0.26 [0.20-0.31]	<0.001
Fruits, cups	0.44 [0.32-0.56]	0.30 [0.17-0.43]	0.49 [0.34-0.64]	0.169
Vegetables, cups *	0.77 [0.68-0.86]	1.04 [0.84-1.24]	0.68 [0.59-0.77]	<0.001
Grain, ounces *	8.15 [7.7-8.5]	7.09 [6.2-7.9]	8.52 [8.0-9.0]	0.004
Meat & beans, ounces	10.7 [10.0-11.5]	11.1 [9.4-12.7]	10.6 [9.8-11.5]	0.638
Added sugar, teaspoon *	11.4 [9.8-13.0]	15.9 [11.5-20.3]	9.90 [8.4-11.3]	0.001
Alcoholic beverage, drinks	1.24 [0.89-1.6]	1.42 [0.61-2.2]	1.18 [0.79-1.5]	0.573
Physical activity *				0.001
Avoid walking	35 (11.7)	5 (6.50)	30 (13.5)	
Walk/moderate exercise	190 (63.5)	41 (53.2)	149 (67.1)	
Regular exercise	74 (24.7)	31 (40.3)	43 (19.4)	

^aPreviously published data.

* Class 1 is significantly different from Class 2 at $P < 0.05$ based on the chi-square test for categorical variables and the t-test for continuous variables.

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