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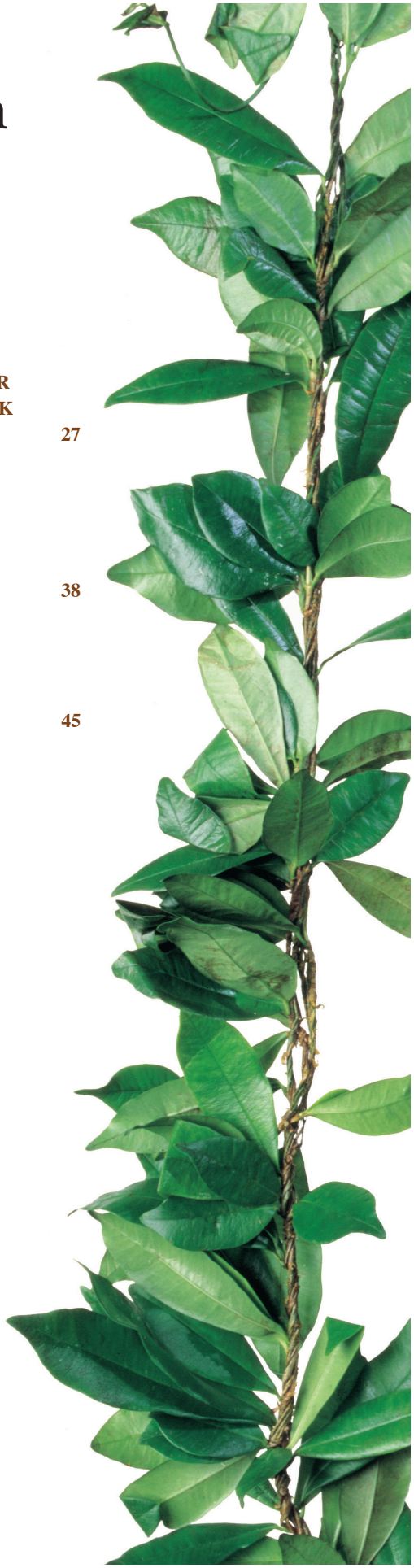

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Aim:

The aim of the Hawai‘i Journal of Health & Social Welfare is to advance knowledge about health and social welfare, with a focus on the diverse peoples and unique environments of Hawai‘i and the Pacific region.

History:

In 1941, a journal then called The Hawai‘i Medical Journal was founded by the Hawai‘i Medical Association (HMA). The HMA had been incorporated in 1856 under the Hawaiian monarchy. In 2008, a separate journal called the Hawai‘i Journal of Public Health was established by a collaborative effort between the Hawai‘i State Department of Health and the University of Hawai‘i at Mānoa Office of Public Health Studies. In 2012, these two journals merged to form the Hawai‘i Journal of Medicine & Public Health, and this journal continued to be supported by the Hawai‘i State Department of Health and the John A. Burns School of Medicine.

In 2018, the number of partners providing financial backing for the journal expanded, and to reflect this expansion the name of the journal was changed in 2019 to the Hawai‘i Journal of Health & Social Welfare. The lead academic partners are now the six units of the UH College of Health Sciences and Social Welfare, including the John A. Burns School of Medicine, Office of Public Health Studies, the Thompson School of Social Work & Public Health, the School of Nursing and Dental Hygiene, the UH Cancer Center, and the Daniel K. Inouye College of Pharmacy. Other partners are the Hawai‘i State Department of Health and the UH Office of the Vice Chancellor for Research. The journal is fiscally managed by University Health Partners of Hawai‘i.

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Severe Tooth Loss and Cardiovascular Disease Among Older Adults in Hawai‘i: A Cross-Sectional Study of Behavioral Risk Factor Surveillance System Data from 2012 to 2020

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Abstract

Despite mounting evidence of the link between oral health and systemic health, there are limited studies on individual- and community-level race/ethnic and socioeconomic correlates of tooth loss and cardiovascular disease (CVD), particularly with regard to Asian and Indigenous populations. This cross-sectional study examined the association between severe tooth loss and CVD and the individual- and community-level sociodemographic correlates of CVD in Hawai‘i, where Native Hawaiian and Asian populations are predominant, utilizing 5 waves of even year data from the Hawai‘i Behavioral Risk Factor Surveillance System collected between 2012 and 2020. Weighted Poisson regression was used to estimate the unadjusted and adjusted prevalence of CVD. Independent variables included demographic variables (age, sex, race and ethnicity), socioeconomic status indicators (education, annual household income, health insurance), and health-related variables (BMI, smoking status, diabetes). A significant association was revealed between severe tooth loss and CVD, which persisted (but was attenuated) with adjustment for sociodemographic and health variables. There were also disparities in CVD prevalence by race and ethnicity (Native Hawaiians had a higher prevalence than White respondents, even after adjustment) and community. The tooth loss-CVD linkage, and racial/ethnic disparities in the prevalence of CVD, point to the importance of a holistic, multi-level approach to public health and collaboration between medical and dental health professionals.

Keywords

Tooth loss, cardiovascular disease, older adults, racial/ethnic disparities

Acronyms

BMI = body mass index
BRFSS = Behavioral Risk Factor Surveillance System
CVD = cardiovascular disease
IRB = Institutional Review Board
NH = Native Hawaiian
OPI = Other Pacific Islander
SDoH = social drivers of health
SES = socioeconomic status

Introduction

Cardiovascular disease (CVD) is the leading cause of death in the US[1] and the state of Hawai‘i specifically.[2] CVD refers to an array of conditions affecting the heart and blood vessels (such as endocarditis, myocarditis, coronary artery disease, peripheral artery disease, myocardial infarction, and stroke), which disproportionately affect older adults (aged 65 years and older).[3] Oral health problems, also common among older adults, are independently associated with CVD and all-cause mortality.[4-6] Meanwhile, socioeconomic and racial/ethnic inequalities render marginalized adults more susceptible to both tooth loss[7-11] and CVD.[12-14] With adults aged 65+ years projected to make up 23% of the US population by 2054 (from 18% today),[15] it is increasingly necessary to address the interrelations of cardiovascular and oral health, and their sociodemographic correlates, among the aging population.

A growing body of literature shows that oral health is related to cardiovascular health. Previous studies have shown that periodontal disease is associated with atherosclerosis,[16] stroke,[17-20] coronary heart disease,[17-21] total CVD,[22] and CVD mortality,[5,19,23] while periodontal treatment has been shown to reduce the markers and risk of CVD.[24-27] Dental caries is also associated with stroke.[28-29] Tooth loss in particular is associated with a wide range of CVD, including coronary heart disease,[30-37] atherosclerosis and atherosclerotic vascular disease,[36,38] cardiac biomarkers,[39] stroke,[6,31] myocardial infarction,[36,40] self-reported CVD,[41] and increased death from CVD.[6,37,42-44] As a result, people with CVD are more likely to present with fewer teeth and poorer oral hygiene.[45]

The association between tooth loss and CVD may be explained by a direct causal mechanism (related to systemic inflammation and/or diet) and an indirect mechanism (related to shared risk factors). Whether the 2 are connected by a causal relationship or by confounding variables remains subject to debate.[46] Tooth loss can be indicative of periodontitis,[38] which may be associated with a systemic inflammatory response and CVD risk in turn.[47,48] Alternatively, tooth loss is associated with difficulty chewing, which has been associated with poorer nutritional status and higher risk for CVD.[49] Additionally, tooth loss and CVD are linked to several common risk factors and behaviors, such as obesity,[50,51] diabetes,[52,53] smoking,[54-56] and poor oral hygiene.[57,58] Importantly, several studies of tooth loss and CVD show that the association is attenuated with adjustment for comorbidities, health risk behaviors (such as smoking), and sociodemographic covariates.[34,40,44]

The risk factors for tooth loss and CVD are distributed unevenly by socioeconomic status (SES)[54,59,60] and race and ethnicity.[61,62] In the state of Hawai‘i, inequalities in modifiable risk factors (such as smoking) are more prevalent among Hawai‘i’s racially/ethnically and socioeconomically marginalized populations,[63] likely contributing to inequalities in CVD and tooth loss: Native Hawaiians (NH), Filipinos, andlow-income and low-education groups are more likely to have severe tooth loss,[11,64] while low-income groups, NH, Filipinos, and Pacific Islanders (PI) have elevated risk of CVD and CVD mortality.[62,65] This suggests that an array of socially determined risk factors, including smoking, help account for the tooth loss and CVD association.

Understanding of the role oral health plays in the development of CVD among older, marginalized populations in Hawai‘i is critical, given that CVD is the leading cause of death in the state and that there are significant differences in overall CVD among Asian subgroups.[62] At-risk subgroups—such as NH, Filipinos, and PI—constitute a large portion of the Hawai‘i population and present higher rates of CVD, coronary heart disease, and stroke than the White population.[62] However, few studies have analyzed differences in severe tooth loss and CVD by race and ethnicity, SES, and community, particularly with regard to Asian and Indigenous populations. In 2023, Waitzfelder et al) crucially examined racial/ethnic differentiation of CVD in disaggregated Asian subpopulations and multiracial individuals in California and Hawai‘i, including NH and PI; however, the study was limited to people with health insurance (a potential sample bias) and did not include severe tooth loss as a risk factor, individual SES measures, or community-level analysis.[62] Other studies of CVD among NHPI have been limited by relatively small sample sizes and sample biases.[66] Meanwhile, there is a paucity of studies regarding the role of race and ethnicity in the tooth loss/CVD association. Although Wiener and Sambamoorthi adjusted for race and ethnicity in their cross-sectional study of tooth loss and CVD, racial/ethnic groupings were limited to Black, White, and Hispanic.[41] While adjustment for socioeconomic factors is customary,[6,30,34-37,40,42,44] less is known about the experiences of different racial/ethnic groups (independent of socioeconomic strata), especially for Asian and Indigenous populations, that bear upon interrelated oral and cardiovascular health outcomes.

Therefore, the present study aimed to explore the association between severe tooth loss and CVD and the socioeconomic, racial/ethnic, and community-level correlates of CVD in Hawai‘i, where NH and Asian populations are predominant. By examining the intersection of severe tooth loss and CVD with key sociodemographic factors at both individual and community levels, the team hopes to contribute to the formulation of inclusive health policies aimed at enhancing cardiovascular, oral, and overall health outcomes for marginalized older adults in Hawai‘i.

Methods

Data Source

Five waves of population-representative, cross-sectional data from the Hawai‘i Behavioral Risk Factor Surveillance System (BRFSS),[67] collected between 2012 and 2020, were analyzed to examine the prevalence of CVD in association with severe tooth loss, demographics, SES variables, and health-related variables. The BRFSS is a cross-sectional annual telephone survey conducted by the states in partnership with the Centers for Disease Control and Prevention. It collects data from non-institutionalized adults (aged 18 years or older) living in the 50 US states, the District of Columbia, and US territories on health-related risk behaviors, chronic health conditions, and use of preventive services. BRFSS provides valid state estimates, within-state estimates, and comparisons across states. The Hawai‘i BRFSS collects detailed racial/ethnic data, including a breakdown of Asian subgroups that were not included in other studies. Hawai‘i BRFSS is the most comprehensive data source available on health-related and chronic health conditions in Hawai‘i and has been very useful in measuring public health objectives and to identify health equity issues. This data can also provide a means for comparing health issues in Hawaii to states nationally and therefore was chosen to further investigate the important linkage between oral health and racial /ethnic disparities in the prevalence of cardiovascular disease. This study was deemed not-human subjects research by the University of Hawai‘i Institutional Review Board (IRB), and therefore not subject to IRB review.

Variables

The dependent variable was CVD, which was measured by asking respondents (yes or no), “Has a doctor, nurse, or other health professional ever told you that you had a heart attack” or “angina/coronary heart disease?” The focal independent variable was severe tooth loss, derived from the question, “Not including teeth lost for injury or orthodontics, how many of your permanent teeth have been removed because of tooth decay or gum disease (1 to 5, 6 or more [but not all], and All)?” Those answering “6 or more (but not all)” or “All” were combined into “severe tooth loss.”

One of the covariates was race and ethnicity, including White (the reference group), NH, PI, Filipino, Japanese, Chinese, and Other (races/ethnicities with small sample sizes). In the BRFSS, respondents may choose up to 6 ethnicities, and 1 ethnicity is then created for reporting purposes. The Hawai‘i BRFSS race and ethnicity documentation methodology is as follows: If NH was 1 of the multiple ethnicities listed (including part NH), NH is coded; if a non-White ethnicity is listed with a White ethnicity, the non-White ethnicity is coded; if there is more than 1 non-White ethnicity listed, the first 1 is coded; and if there is more than 1 White ethnicity listed, the first 1 is coded.[68]

Other covariates included in the analysis were age (50-59 [the reference group], 60-69, 70-79, and ≥80 years), sex (female [the reference group] and male), education (high school/GED or lower, college 1-3 years, and college 4+ years [the reference group]), annual household income ($0–$24,999, $25,000–$49,999, $50,000–$74,999, ≥$75,000 [the reference group], and unknown), health insurance status (yes or no), body mass index (BMI) (normal weight [the reference group], overweight, obese, underweight, and unknown), smoking status (never [the reference group], former, current, and unknown), and diabetes (yes or no). Since the BRFSS is not designed to generate population estimates at the zip code-level and to protect the privacy of the participants, zip code level data is not be released. Hawai'i Health Data Warehouse aggregated zip codes to 23 communities to show disparities by geographical areas (https://hhdw.org/data-sources/behavioral-risk-factor-surveillance-system/brfss-data-request/).

Analytical Sample

The BRFSS oral health questions were asked biannually in even years; therefore, the even year data from 2012 to 2020 were used. The original sample size of participants aged 50 years and older was 23 347, accounting for 60.7% of the total sample of 384 86 aged 18 and older. The final analytical sample size was 22 704 after excluding 2.8% of missing responses, including 17 respondents who did not respond to the CVD question, 517 participants who did not respond to the question on tooth loss, and 109 respondents missing information on sex, education, and health plan (**Figure 1**). Missing responses in income (2462, 10.8%) were coded as "unknown" due to the large proportion of missing.

Statistical Analysis

All analysis was conducted using R version 4.0.5 (R Foundation for Statistical Computing, Vienna, Austria) to account for the complex survey design and followed BRFSS data reporting rules for the analytical sample. Equal survey weights were assigned to each survey year. Descriptive analysis was conducted to summarize the sample characteristics and results were summarized in **Table 1**. For bivariate analyses, the weighted prevalence was calculated of CVD by all the covariates (**Table 2**). **Table 3** summarizes results from the weighted Poisson regression modelwith quasi-likelihood that was used to estimate the crude prevalence ratios (PR) and adjusted PR controlling for demographic variables (age, sex, race and ethnicity) (Model 1), SES indicators (education, annual household income, and health insurance/health plan) (Model 2), and health-related variables (BMI, smoking status, and diabetes) (Model 3). **Table 4** shows the prevalence of CVD with 95% CI across all communities.

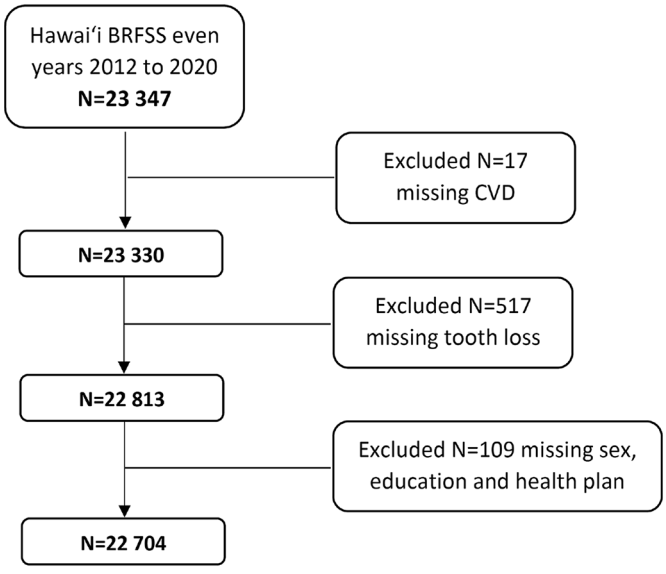

Figure 1. depicts a flow chart of the sample selection. Of the total sample of 23 347 respondents aged 50 and older (BRFSS even years from 2012 to 2020), 17 were excluded for missing data on cardiovascular disease (CVD); 517were excluded for missing data on tooth loss; and 109 were excluded for missing data on sex, education, and health plan. This left a final analytical sample size of 22 704 respondents.

Results

Table 1 presents an overview of the sample characteristics including weighted and unweighted statistics from 5 waves of BRFSS data. The numbers reported are weighted statistics. It shows that 16.9% of respondents reported experiencing severe tooth loss. Females constituted the majority of the sample at 52.4%, while males comprised the remaining 47.6%. White respondents represented nearly 28.5% of the sample and NH made up 12.8%. The percentages of Filipino, Japanese and Chinese, respondents were 14.5%, 26.7%, and 6.2%, respectively. Almost all participants (95.6%) had health insurance and the majority (54.0%) identified as never-smokers. Finally, 16.7% of the sample reported having diabetes.

Table 2 illustrates bivariate associations, presenting the weighted prevalence of CVD by all covariates. Across the entire sample, the prevalence of CVD was 9.1%. The prevalence of CVD for those with severe tooth loss was 15.9%, more than 2 times higher than those without severe tooth loss. Moreover, significant disparities in the prevalence of CVD were observed across almost all covariates. Males, for instance, showed a significantly higher prevalence of CVD compared to females. Regarding racial/ethnic differences, NH demonstrated a 50% higher prevalence of CVD compared to Whites.

Model 1 of **Table 3** shows that, when adjusting for all the demographics, the adjusted prevalence ratio (APR) of CVD associated with severe tooth loss was 1.66 (95% CI: 1.45, 1.91, $P<.001$), suggesting a 66% higher prevalence than those without severe tooth loss. Adjusted for education, household income, and health plan in Model 2, the APR of severe tooth loss was reduced to 1.53 (95% CI: 1.33, 1.77, $P<.001$). The APR of severe tooth loss was further reduced to 1.36 (95% CI: 1.18, 1.56, $P<.001$) after BMI, smoking status, and diabetes were incorporated. These findings suggest that SES and health-related factors partially accounted for the association between severe tooth loss and the prevalence of CVD. As for racial/ethnic disparities, compared to Whites, NHs, reported a 54% higher prevalence of CVD (APR=1.54, 95% CI: 1.32, 1.79, $P<.001$) and the APR reduced after SES and health indicators were included in Models 2-3. No other racial/ethnic disparities in CVD were identified. Interestingly, compared to those who have no health plan, those having a health plan exhibited close to 50% higher prevalence of CVD in Model 2 (PR=1.48, 95% CI: 1.04, 2.11, $P<.031$), but this was no longer significant when BMI, smoking status and diabetes were added in Model 3

Table 4 describes the prevalence of CVD by community. It shows that the prevalence of CVD ranged from 6.2% in Salt Lake/Foster Village and North Shore/La'ie to 13.9% (95% CI: 10.3%, 18.5%) in Nanakuli/Waianae. The highest prevalence of CVD was found in Nanakuli/Wai'anae (O'ahu), Hilo (Hawai'i island Lahaina/Wailuku (Maui), and Puna/Kau (Hawai'i island). It was lowest in Salt Lake/Foster Village (O'ahu), North Shore/La'ie (Oahu), Kaimuki/Palolo/Waikiki (O'ahu), and Upcountry/Hana (Maui).

Table 1. Unweighted and Weighted Sample Characteristics, Hawai'i Behavioral Risk Factor Survey Respondents Ages 50+, 2012-2020 Even Years (Continued on next page)

	Sample Size (%)	Average Weighted Population (Weighted %)
Total Sample	N = 22704	N = 510384
Severe tooth loss (6+)		
Yes	3935 (17.3%)	86417 (16.9%)
No	18769 (82.7%)	423967 (83.1%)
Age group		
50-59	6885 (30.3%)	182124 (35.7%)
60-69	8286 (36.5%)	169216 (33.2%)
70-79	5153 (22.7%)	101984 (20.0%)
80+	2380 (10.5%)	57060 (11.2%)
Sex		
Female	12320 (54.3%)	267484 (52.4%)
Male	10384 (45.7%)	242900 (47.6%)
Race and ethnicity		
White	9033 (39.8%)	145374 (28.5%)
Native Hawaiian	3409 (15.0%)	65518 (12.8%)
Other PI	333 (1.5%)	7146 (1.4%)
Filipino	2212 (9.7%)	74037 (14.5%)
Japanese	4525 (19.9%)	136399 (26.7%)
Chinese	1010 (4.4%)	31603 (6.2%)
Other	2182 (9.6%)	50306 (9.9%)

Table 1. Unweighted and Weighted Sample Characteristics, Hawai'i Behavioral Risk Factor Survey Respondents Ages 50+, 2012-2020 Even Years (Continued from previous page)

	Sample Size (%)	Average Weighted Population (Weighted %)
Education		
College 4 or more years	9928 (43.7%)	156270 (30.6%)
College 1-3 years	6573 (29.0%)	175788 (34.4%)
High school or GED	6203 (27.3%)	178325 (34.9%)
Household income		
$75,000 or higher	7035 (31.0%)	168435 (33.0%)
$50,000-$74,999	3440 (15.2%)	77720 (15.2%)
$25,000-$49,000	4996 (22.0%)	109566 (21.5%)
$0-$24,999	4771 (21.0%)	94612 (18.5%)
Unknown/missing	2462 (10.8%)	60050 (11.8%)
Health plan		
No health plan	975 (4.3%)	22436 (4.4%)
Has health plan	21729 (95.7%)	487947 (95.6%)
BMI categories		
Normal weight	8808 (38.8%)	192125 (37.6%)
Overweight	7830 (34.5%)	175890 (34.5%)
Obese	4696 (20.7%)	108974 (21.4%)
Underweight	615 (2.7%)	13601 (2.7%)
Unknown/missing	755 (3.3%)	19794 (3.9%)
Smoking status		
Never smoker	11932 (52.6%)	275381 (54.0%)
Former smoker	7836 (34.5%)	167249 (32.8%)
Current smoker	2295 (10.1%)	50503 (9.9%)
Unknown/missing	641 (2.8%)	17251 (3.4%)
Diabetes		
No diabetes	19305 (85.0%)	424924 (83.3%)
Has diabetes	3399 (15.0%)	85460 (16.7%)

Table 2. Weighted Prevalence of CVD and Unadjusted Prevalence Ratio of CVD Among Adults Ages 50+ Years by All Covariates, Hawai'i Behavioral Risk Factor Survey, 2012-2020, Even Years (Continued on next page)

	Prevalence (95% CI)	Prevalence Ratio (95% CI)	*P*-value
Total Sample	9.1% (8.5,9.6)		
Severe tooth loss (6+)			
No	7.7% (7.1, 8.2)	Ref	
Yes	15.9% (14.3,17.7)	2.08 (1.83, 2.37)	<.001
Age group			
50-59	5.3% (4.6, 6.1)	Ref	
60-69	8.5% (7.7, 9.3)	1.59 (1.34, 1.89)	<.001
70-79	11.8% (10.6,13.2)	2.22 (1.86, 2.65)	<.001
80+	17.8% (15.4,20.4)	3.34 (2.74, 4.07)	<.001
Sex			
Female	6.5% (5.9, 7.3)	Ref	
Male	11.8% (11.0,12.7)	1.81 (1.59, 2.05)	<.001

Table 2. Weighted Prevalence of CVD and Unadjusted Prevalence Ratio of CVD Among Adults Ages 50+ Years by All Covariates, Hawai'i Behavioral Risk Factor Survey, 2012-2020, Even Years (Continued from previous page)

	Prevalence (95% CI)	Prevalence Ratio (95% CI)	*P*-value
Race and ethnicity			
White	8.7% (8.0, 9.6)	Ref	
Native Hawaiian	12.8% (11.4,14.4)	1.46 (1.26, 1.70)	<.001
Other PI	10.3% (6.9,15.1)	1.18 (0.79, 1.76)	.42
Filipino	7.5% (6.1, 9.3)	0.86 (0.69, 1.08)	.20
Japanese	8.4% (7.4, 9.7)	0.96 (0.82, 1.14)	.66
Chinese	7.9% (6.0,10.4)	0.91 (0.68, 1.22)	.51
Other	9.5% (7.7,11.7)	1.09 (0.87, 1.36)	.47
Education			
College 4 or more years	7.1% (6.4, 7.8)	Ref	
College 1-3 years	9.1% (8.2,10.1)	1.30 (1.12, 1.49)	<.001
High school or GED	10.7% (9.7,11.8)	1.52 (1.32, 1.75)	<.001
Household income			
$75,000 or higher	6.9% (6.1, 7.8)	Ref	
$50,000-$74,999	7.9% (6.7, 9.3)	1.15 (0.93, 1.41)	.192
$25,000-$49,999	9.7% (8.6,10.9)	1.40 (1.18, 1.66)	<.001
$0-$24,999	13.5% (12.1,15.1)	1.96 (1.66, 2.31)	<.001
Unknown/missing	8.4% (6.9,10.3)	1.22 (0.97, 1.54)	.088
Health plan			
No health plan	6.2% (4.3,8.7)	Ref	
Has health plan	9.2% (8.6,9.8)	1.49 (1.05, 2.12)	.027
BMI categories			
Normal weight	7.2% (6.4, 8.0)	Ref	
Overweight	9.3% (8.4,10.2)	1.29 (1.11, 1.50)	<.001
Obese	12.1% (10.8,13.5)	1.68 (1.43, 1.97)	<.001
Underweight	10.2% (6.9,15.0)	1.43 (0.95, 2.15)	.087
Unknown/missing	8.1% (5.7,11.4)	1.13 (0.79, 1.62)	.51
Smoking status			
Never smoker	7.1% (6.4, 7.9)	Ref	
Former smoker	12.4% (11.4,13.5)	1.75 (1.53, 1.99)	<.001
Current smoker	9.7% (8.2,11.5)	1.37 (1.13, 1.66)	.002
Unknown/missing	5.3% (3.4, 8.0)	0.74 (0.48, 1.15)	.181
Diabetes			
No diabetes	7.3% (6.7, 7.8)	Ref	
Has diabetes	18.0% (16.2,20.0)	2.49 (2.19, 2.82)	<.001

Table 3. Weighted Prevalence Ratio of CVD Adjusting for Different Sets of Covariates (Continued on next page)						
	Model 1		Model 2		Model 3	
	PR (95%CI)	*P*-value	PR (95%CI) Ratio and 95% CI	*P*-value	PR (95%CI)	*P*-value
Total Sample						
Severe tooth loss (6+)						
No						
Yes	1.66 (1.45, 1.91)	<.001	1.53 (1.33, 1.77)	<.001	1.36 (1.18, 1.56)	<.001
Age group						
50-59						
60-69	1.59 (1.35, 1.89)	<.001	1.56 (1.32, 1.85)	<.001	1.51 (1.27, 1.79)	<.001
70-79	2.19 (1.83, 2.62)	<.001	2.12 (1.77, 2.54)	<.001	2.02 (1.69, 2.43)	<.001
80+	3.41 (2.77, 4.20)	<.001	3.22 (2.62, 3.96)	<.001	3.43 (2.79, 4.22)	<.001
Sex						
Female						
Male	1.88 (1.66, 2.13)	<.001	1.95 (1.72, 2.21)	<.001	1.78 (1.57, 2.02)	<.001
Race and ethnicity						
White						
Native Hawaiian	1.54 (1.32, 1.79)	<.001	1.45 (1.25, 1.69)	<.001	1.23 (1.05, 1.43)	.008
Other PI	1.36 (0.90, 2.04)	.1426	1.28 (0.85, 1.92)	.22	1.05 (0.71, 1.55)	.80
Filipino	0.92 (0.73, 1.15)	.45	0.85 (0.68, 1.06)	.140	0.81 (0.65, 1.02)	.068
Japanese	0.90 (0.76, 1.05)	.184	0.89 (0.76, 1.05)	.166	0.86 (0.73, 1.01)	.058
Chinese	0.92 (0.69, 1.21)	.54	0.92 (0.69, 1.22)	.55	0.97 (0.73, 1.28)	.81
Other	1.14 (0.91, 1.44)	.24	1.09 (0.87, 1.37)	.44	1.03 (0.82, 1.29)	.79
Education						
College 4 or more years						
College 1-3 years			1.18 (1.02, 1.37)	.031	1.13 (0.98, 1.31)	.099
High school or GED			1.09 (0.93, 1.27)	.31	1.02 (0.88, 1.19)	.78
Household income						
$75,000 or higher						
$50,000-$74,999			1.03 (0.84, 1.26)	.81	1.03 (0.84, 1.26)	.80
$25,000-$49,000			1.17 (0.97, 1.39)	.094	1.15 (0.97, 1.38)	.112
$0-$24,999			1.57 (1.31, 1.87)	<.001	1.58 (1.33, 1.88)	<.001
Unknown/missing			1.06 (0.84, 1.34)	.60	1.08 (0.86, 1.36)	.50
Health plan						
No health plan						
Has health plan			1.48 (1.04, 2.11)	.031	1.37 (0.96, 1.95)	.083
BMI categories						
Normal weight						
Overweight					1.20 (1.04, 1.39)	.014
Obese					1.47 (1.25, 1.73)	<.001
Underweight					1.25 (0.84, 1.84)	.270
Unknown/missing					1.73 (1.18, 2.52)	.005

Table 3. Weighted Prevalence Ratio of CVD Adjusting for Different Sets of Covariates (Continued from previous page)						
	Model 1		**Model 2**		**Model 3**	
	PR (95%CI)	***P*-value**	**PR (95%CI) Ratio and 95% CI**	***P*-value**	**PR (95%CI)**	***P*-value**
Smoking status						
Never smoker						
Former smoker					1.37 (1.20, 1.56)	<.001
Current smoker					1.23 (1.01, 1.50)	.039
Unknown/missing					0.57 (0.35, 0.90)	.017
Diabetes						
No diabetes						
Has diabetes					1.99 (1.74, 2.27)	<.000

Table 4. Prevalence of CVD with 95% CI Across All Communities		
Community	**Sample Size**	**Prevalence of CVD (95% CI)**
Nanakuli/ Waianae - Honolulu	468	13.9% (10.3,18.5)
Hilo – Hawai‘i	1191	11.8% (9.5,14.6)
Lahaina/ Wailuku - Maui	1257	11.3% (8.8,14.4)
Puna/ Kau – Hawai‘i	1359	11.3% (9.3,13.7)
Kailua/ Waimanalo - Honolulu	824	11.0% (8.2,14.7)
Kona – Hawai‘i	1175	10.6% (8.3,13.5)
Mililani/ Wahiawa - Honolulu	804	10.4% (7.9,13.6)
Aiea/ Pearl City - Honolulu	923	9.8% (7.7,12.4)
Hanalei/ Kapaa – Kaua‘i	1249	9.4% (7.5,11.7)
Moloka‘i - Maui	410	9.3% (5.6,15.1)
N.Hawai‘i - Hawaii	969	9.1% (6.9,11.8)
Ka‘a‘awa/ Kahalu‘u/ Kaneohe - Honolulu	833	8.9% (6.6,12.1)
Nu‘uanu/ Kalihi/ Moanalua - Honolulu	980	8.4% (6.5,10.9)
Mānoa/ Upper Makiki - Honolulu	931	8.1% (6.2,10.6)
Ala Moana - Honolulu	569	7.8% (5.4,11.0)
Kahului - Maui	1168	7.7% (5.9,10.0)
Wai‘alae/ Kahala/ Hawai‘i Kai - Honolulu	880	7.7% (5.6,10.4)
Lihue-Waimea – Kaua‘i	1625	7.6% (5.9, 9.6)
Lanai - Maui	205	7.5% (3.9,13.9)
Waipahu/ Kapolei/ ‘Ewa - Honolulu	1295	7.5% (5.8, 9.8)
Upcountry/ Hana - Maui	1251	7.3% (5.7, 9.4)
Kaimuki/ Palolo/ Waikiki - Honolulu	1124	7.1% (5.3, 9.4)
N.Shore/ Lā‘ie - Honolulu	293	6.2% (3.4,11.1)
Salt Lake/ Foster Village - Honolulu	294	6.2% (3.3,11.2)

Discussion

This study examined the association between severe tooth loss and CVD and the individual- and community-level correlates of CVD among older adults in Hawai‘i. The findings revealed a significant association between severe tooth loss and CVD, a relationship that was partly accounted for by SES and risk factors. After adjusting for covariates (including smoking, BMI, diabetes, income, and education), the association between severe tooth loss and CVD persisted but was attenuated. These findings align with past studies showing a significant association between tooth loss and CVD that is weakened after adjustment for comorbidities, socioeconomic variables, and health risk behaviors.[34,40,44]

The study further revealed racial/ethnic differentiation of CVD. Compared to White respondents, NH had a higher prevalence of CVD. Socioeconomic inequalities and uneven distribution of risk factors appear to partly explain the association. NH are overrepresented in lower-income and lower-education groups, and some risk factors (including smoking, obesity, and diabetes) are more prevalent among NH.[63,69-70] However, the higher prevalence of CVD for NH even after adjustment for SES variables, smoking, overweight, and diabetes indicates that the association is partly attributable to variables beyond the scope of the present study. These might include discrimination, cultural values, specific risk behaviors (such as betel nut chewing), and historical traumas.[70-72] For instance, in 2008 Kaholokula et al found specific cultural and material barriers to heart health among NHPI that include "poor knowledge of heart failure, lack of trust in physicians' care, poor physician-patient relations, finances, dietary changes, and competing demands on time".[73] Importantly, in 2023 Waitzfelder et al found a higher prevalence of CVD among multiracial Asian Pacific Islander populations,[62] pointing to the value of racial/ethnic analysis (and well-defined racial/ethnic disaggregation) in the examination of cardiovascular health disparities. Given this evidence of racial/ethnic disparities in cardiovascular health and of the tooth loss/CVD linkage, the specific function of race and ethnicity in the relationship between oral and cardiovascular health warrants further investigation.

The role of racial/ethnic marginalization in this association is particularly important considering the historical good health of NH (documented by Indigenous oral histories and early Western records) prior to colonial contact and subsequent exposure to communicable diseases, violent land dispossession, coerced changes to social structures, and suppression of language and culture.[71,74] The legacies of colonialism and racism continue to subjugate NH, manifest in poorer health outcomes than the general population. In addition to more prevalent CVD, NH have more prevalent severe tooth loss[11] and higher mortality[75] – the *very definition* of racism per Ruth Wilson Gilmore, who describes racism as the production of "group differentiated vulnerability to premature death".[76]

Finally, this study revealed CVD disparities by community in Hawai‘i, indicating that socioeconomic factors operate on an aggregate level to impact cardiovascular health. The prevalence of CVD was highest in areas with relatively low education and income levels: Nanakuli/Wai‘anae, Hilo, Lahaina/Wailuku, and Puna/Kau. In Makua Valley, Makaha, Wai‘anae Kai, and Nanakuli—the census tracts that make up the general Nanakuli/Wai‘anae area—the median family incomes are $49,226, $44,677, $42,261, and $52,333, respectively.[77] By contrast, the median family incomes of Foster Village and Salt Lake Country Club—comprising the area with the lowest prevalence of CVD, Salt Lake/Foster Village—are $104,625 and $89,728, respectively.[77] These results indicate an association between community-level socioeconomic disparities and cardiovascular disease, supporting previous findings that show inadequate access to care and poorer cardiovascular health outcomes related to rurality.[78]

The Social Drivers of Health (SDoH) framework helps clarify the social systems of power that determine individual and community health outcomes, including the racial/ethnic and community-level disparities in CVD. The SDoH model highlights hierarchical social systems that result in differing social, economic, and environmental conditions, including upstream material and environmental factors (such as housing and air quality) and downstream behavioral factors (such as oral hygiene and smoking). Following this paradigm, policy efforts that aim to improve interrelated oral and cardiovascular health outcomes must account for the structural drivers of risk factors and their unequal distribution among marginalized populations. A holistic, multi-level approach to public health policy is in order: such measures might range from national-level poverty alleviation initiatives to community-level oral hygiene education programs. Interventions on the provider level must prioritize collaboration across medical and dental systems, expanded access to preventive and restorative medical and oral health care, and cultural competence among health professionals.

Strengths/Limitations

This study was subject to several limitations. First, BRFSS data are self-reported and participation is contingent on physical and mental ability to complete the survey. When studying older adults, this limitation can lend to possible over or under-representation of data. Second, a causal relationship cannot be verified with cross-sectional data. Third, individuals were categorized into a single sex and racial/ethnic group, potentially obscuring the specific cardiovascular health outcomes for nonbinary or multiracial/multiethnic individuals. Lastly, there might be the healthy behavior bias as people who take care of their teeth are less likely to have tooth loss and engage in other health promoting behaviors that would also reduce their risk of CVD. Despite these limitations, the study extends important research on the oral health and cardiovascular health linkage by examining the association of tooth loss and CVD and the individual- and community-level sociodemographic correlates of CVD in Hawai'i.

Conflict of Interest

None the authors identify a conflict of interest.

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Availability of Locally Produced Foods in the Children's Healthy Living Center's Food Cost Survey for the United States Affiliated Region

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Abstract

The Children's Healthy Living Center of Excellence (CHL Center) conducted a food cost survey (CHL FCS) in the United States Affiliated Pacific Region (USAPR) that was modified from the United States Department of Agriculture Community Food Security Assessment Toolkit (CFSAT). The CFSAT is based on the 1999 United States Department of Agriculture (USDA) Thrifty Food Plan (TFP). The TFP estimates the cost of consuming a healthy, cost-conscious diet at home and is based on food cost, nutrients in food, nutrition guidance and What We Eat in America (WWEIA). The USAPR is not included in the WWEIA survey. The CFSAT's 87 food items were included in the CHL FCS. The purpose of this study is to describe the availability of the food items in stores within the USAPR and what items were locally produced. In March 2021, food cost data were collected from 92 stores in the jurisdictions of Alaska, American Samoa, Commonwealth of the Northern Mariana Islands, Guam, and Hawai'i. Most CHL FCS food items were available in at least 1 store in each jurisdiction with a range from 0 to 14 items missing from all stores. The presence of local food items was limited across jurisdictions, ranging from 8 to 27 items. Geographic isolation and small populations affect the availability of food items. Inclusion of the region's cultural and dietary practices in national nutritional guidance is crucial in preserving local food cultures, and the production and consumption of local foods.

Keywords

Food cost survey; local food availability; United States Affiliated Pacific Region

Abbreviations and Acronyms

CACFP = Child and Adult Care Food Program
CFSAT= USDA Community Food Security Assessment Toolkit
CHL = Children's Healthy Living Program
CHL Center = Children's Healthy Living Program Center of Excellence
CHL FCS = Children's Healthy Living Program Food Cost Survey
CNMI = Commonwealth of the Northern Mariana Islands
FCS = Food Cost Survey
FSM = Federated States of Micronesia
NHANES = United States National Health and Nutrition Examination Survey
NSLP = National School Lunch Program
RMI = Republic of the Marshall Islands
SNAP = Supplemental Nutrition Assistance Program
TFP = Thrifty Food Plan
US = United States
USAPR = United States Affiliated Pacific Region
USDA = United States Department of Agriculture
WWEIA = What We Eat in America
WIC = Special Supplemental Nutrition Program for Women, Infants and Children

Introduction

The United States Affiliated Pacific Region (USAPR) is an expansive and diverse region that includes the states of Alaska and Hawai'i and the US-affiliated Pacific Islands of American Samoa, the Commonwealth of the Northern Mariana Islands (CNMI), the Republic of Palau, the Federated States of Micronesia (FSM: Chuuk, Kosrae, Pohnpei, Yap), the Republic of the Marshall Islands (RMI) and Guam, collectively referred to as jurisdictions. The region is characterized as vast and isolated, with Indigenous populations that are culturally and biologically distinct with native languages, customs, and fragile biodiverse ecosystems that remain important for achieving sustainable healthy living and prevention of obesity.[1-3] The region is not in the US National Health and Nutrition Examination Survey (NHANES) and has limited human nutrition intake data. NHANES collects data on the health and nutritional status of the contiguous US population.[4] The exclusion from NHANES means that the region's unique dietary patterns are not reflected in national statistics. Further the foods consumed in the region are not well known and therefore not prioritized for analysis of their nutrient value, and not available in dietary assessment tools. Thus, the nutritional assessments of the population require substitutions with best matches. NHANES data is foundational in the formulation of the Thrifty Food Plan (TFP), ensuring that it is nutritionally adequate, cost-effective, and reflective of current dietary patterns.[5]

The TFP is a model diet plan created by the US Department of Agriculture (USDA) that represents the cost of groceries needed to provide a healthy, balanced diet on a minimal budget. The TFP consists of types and quantities of foods that can be bought by individuals or families to achieve a nutritious diet on a limited food budget, as defined under 7 US Code § 2012 of the Food and Nutrition Act of 2008.[5] The cost of the TFP is used to set maximum Supplemental Nutrition Assistance Program (SNAP) allotments.[6] SNAP food benefits supplement households' food budgets to reduce poverty and food insecurity.

The Children's Healthy Living Program (CHL) was established in 2011 and is a partnership among the remote Pacific jurisdictions of American Samoa, the Commonwealth of the Northern

Mariana Islands (CNMI), the Republic of Palau, the Federated States of Micronesia (FSM: Chuuk, Kosrae, Pohnpei, Yap), the Republic of the Marshall Islands (RMI), Guam, Alaska, and Hawai'i. CHL's aim is to build social/cultural, physical/built, and political/economic environments that will promote active play and intake of healthy food to prevent young child obesity in the USAPR. As the region has no US National Nutrition monitoring (eg, NHANES), CHL collected child, household and community level data to help guide future children's obesity prevention programs and policies.[7]

CHL conducted a community randomized environmental intervention trial, from 2013 - 2015 to address childhood obesity through affecting the food and physical activity environment. The intervention trial consisted of 4 matched pair communities in American Samoa, CNMI, Guam, and Hawai'i and 2 matched-pair communities in Alaska. The communities were selected based on these criteria: a population of over 1000 people, at least 25% of the population being of Indigenous/native descent (or 15% in Alaska because no area with over 1000 people had more than 25% Indigenous/native), and at least 10% of the population being under 10 years old.[7]

As part of the data collection, CHL initially conducted an initial Food Cost Survey (FCS) in the CHL jurisdictions in 2014. The CHL FCS was based on the USDA TFP list found in the USDA Community Food Security Assessment Toolkit (CFSAT),[8] which contains 87 food items in 8 food categories. The CHL FCS found food cost in the CHL jurisdictions to be 1.3 to 2.1 times higher than food cost in Portland, Oregon.[9] Weekly food costs for a family of 4 ranged from $286 in Rota, CNMI, to $174 in Anchorage, Alaska, with a mean of $216, as compared to $142 for Portland, Oregon. Food price variation was greatest among dairy foods while fruits varied the least. Dairy comprised less than 7% of the total food costs for Hawai'i and Alaska but greater than 11% of the weekly food costs in the additional CHL jurisdictions. For several CHL jurisdictions, certain TFP items were unavailable (eg, bagels) or exceptionally expensive (eg, 1% milk, $17.76/gal in CNMI). The price for missing items was estimated by taking the Anchorage, Alaska price and adjusting it based on the difference between the median prices of all TFP menu items in the jurisdiction and Anchorage.[9]

In March 2021, as part of the CHL Center of Excellence grant, a second round of the CHL FCS was conducted. The 2021 CHL FCS added questions about whether food items were locally produced. "Locally produced" was defined as items grown, harvested, and/or produced in the jurisdiction.

To better understand the impact of the TFP, which reflects dietary patterns of the contiguous US rather than the region's unique dietary patterns, this study described the availability of CHL FCS food items and the number of locally produced food items in selected CHL jurisdiction stores in 2021. To accomplish this, this study examined: the number of CHL FSC items available and the number of CHL FSC items that were locally produced.

Methods

In March 2021, CHL collected food cost data using the CHL FCS in Alaska, American Samoa, CNMI, Guam, and Hawai'i. An inventory of food stores was developed for selected communities in each CHL jurisdiction. Store selection criteria included: (1) at least 1 store was located in a low-income neighborhood and (2) stores were full service (grocery stores or supermarkets) with exceptions for convenience stores if conventional food stores were unavailable and fruits and vegetables were offered. From the inventory, 3 stores meeting the selection criteria were selected for each community. If less than 3 stores met the selection criteria in a community, all eligible stores were surveyed. Stores were selected by the CHL jurisdiction team lead.

The CFSAT food store survey instruments and materials have been part of past food costs surveys conducted by the University of Alaska Fairbanks Cooperative Extension Service. The CHL FCS adopted the same survey protocol under the guidance of the University of Alaska Fairbanks researchers.[9] The CHL FCS collected data on item availability, weight, unit of measure (ie, ounces), price, and if it was locally produced. If a locally produced option was available for the item, an additional question was asked to determine whether the locally produced item was selected.

CHL jurisdiction staff collected the data and were required to attend an online training prior to the March 2021 CHL FCS data collection. The food cost data was collected using the iOS application, Ninox.[10] Food cost data was recorded for 87 items in 8 food group categories (**Supplemental Table 1**).[8] If the food item was not present in the store at the time of the data collection, the food item was marked as "missing". Notes were added to the data collection form if there was shelf space for the item but the item was not present.

If a locally produced choice for the food item was available, the data collector recorded the food item as having a locally produced item available. The price of the locally produced item was included in the cost analysis if it was the best match for the food item according to the CFSAT protocol. The CFSAT protocol requires the food item to be a specific size, and if more than 1type of food item is available at the specified size, then the lowest priced item is to be selected.

For example, if a store has locally produced bananas and imported bananas then the food item would be recorded as having a locally produced food item available. The specific size for bananas would be price per pound. As both the imported and local bananas were priced per pound the lower cost item would be selected. In this example, locally produced bananas are $1.50/lb. and the imported bananas are $0.99/lb. The imported banana price would be recorded, as the price is lower. The data collectors would record that the reason the locally produced bananas were not selected was due to the higher cost per pound.

Supplemental Table 1. Children's Healthy Living Food Cost Survey Food Items by Food Category

Food Category	Food Item
Fruits & Vegetables, fresh	Apples any variety (bagged or loose)
	Bananas
	Grapes (green or red)
	Melon (specify type)
	Oranges, any variety (bagged or loose)
	Carrots, unpeeled (bagged or loose)
	Celery, bunch
	Green pepper
	Lettuce, leaf (green or red)
	Onions, yellow (bagged or loose)
	Tomatoes, any variety
	Potatoes, any variety
Fruits & Vegetables, canned / frozen	Oranges, mandarin (juice or light syrup)
	Peaches, any variety (light syrup)
	Mushrooms, pieces, canned
	Spaghetti sauce, any variety
	Tomato sauce, any variety
	Orange juice, frozen concentrate
	Broccoli, chopped, frozen
	Green beans, any variety, frozen
	Green peas, any variety, frozen
	French fries, any variety, frozen
	Grains Bread, white, enriched
	Bread, whole wheat
	Hamburger buns, enriched
	Rolls, dinner, enriched
	French or Italian Bread, enriched
	Bagels, plain, enriched
	Bread crumbs, plain
	Ready-to-eat cereal, Corn Flakes
	Ready-to-eat cereal, Toasted Oats
	Flour, white, all-purpose, enriched
	Macaroni, elbow-style, enriched
	Noodles, yolk-free, enriched
	Popcorn, microwave, any variety
	Rice, white, long-grain, enriched
	Spaghetti noodles, any variety, enriched
Dairy	Milk, 1% milk fat
	Milk, whole
	Cheese, cheddar, mild or medium
	Cheese, cottage, any variety
	Cheese, mozzarella, whole
	Evaporated milk, any variety
Meats	Beef, ground, lean (16 to 23% fat)
	Chicken, fryer, cut-up or whole
	Chicken, thighs
	Turkey, ground
	Pork, ground
	Turkey breast
	Eggs, grade A, large
	Fish, flounder, cod, tilapia or similar, frozen
	Tuna fish, chunk-style, water packed
	Beans, garbonzo, canned (chick peas)
	Beans, kidney, canned
	Beans, baked, vegetarian, canned
Fats & Oils	Margarine, stick
	Shortening, vegetable
	Mayonnaise, regular
	Vegetable oil, any type
Sugars	Sugar, brown (dark or light)
	Sugar, powdered
	Sugar, white, granulated
	Jelly, grape
	Molasses, any type
	Pancake syrup, any type
	Chocolate chips, semi-sweet
	Fruit drink, refrigerated, any flavor
	Fudgsicles, ice milk
Spices and Condiments	Baking powder
	Baking soda
	Chili powder
	Cinnamon
	Cumin
	Onion powder
	Garlic powder
	Italian herb seasoning
	Oregano
	Paprika
	Black pepper, ground
	Salt, any type
	Vanilla, any type
	Chicken bouillon, reduced-sodium, cubes
	Catsup, any type
	Soy sauce, reduced-sodium
	Lemon juice, bottled
	Gelatin, powdered, unflavored
	Chocolate drink powder

CHL FCS data was collected using Ninox software (Ninox Software GmbH, Berlin, Germany). Ninox compiled the data into a spreadsheet. Discrepancies and implausible data were identified and resolved following an established protocol developed by the CHL data workgroup. The food items were sorted by food group and counts per food group using SAS 9.4 (SAS Institute Inc., Cary, NC). Human studies approval for the CHL study was obtained from the Committee on Human Studies at the University of Hawai‘i at Mānoa (#18915) and the Institutional Review Board (IRB) at the University of Guam (#IRB-22-34). The authors collected the food cost data or were responsible for its collection.

Results

CHL FCS data were collected in 92 stores across the jurisdictions (Alaska = 12, American Samoa =16, CNMI = 21, Guam = 19, and Hawai‘i = 24) in March 2021. When looking at items by individual store, all jurisdictions had some missing food items, with low-sodium chicken bouillon cubes as the most common missing item (**Table 1**). Communities in American Samoa, CNMI, and Guam were found to have more missing items when compared to Alaska and Hawai‘i (**Table 1**).

When looking at locally produced items across all stores surveyed in the jurisdiction, Hawai‘i had the most locally produced items available (27 out of 87 items) and American Samoa had the fewest locally produced items available (N=8). When comparing the food item categories across the jurisdictions, the grain group category had the most locally produced food items compared to the other food categories with an average of 5 (range 4 to 6) of the 15 items. None of the jurisdictions had locally produced fats & oils category items (**Table 2**).

When a locally produced food was available, the item was chosen as the "best" option the majority of the time, with CNMI having all the locally produced items chosen and Alaska with the least (7 out of 12 items) (**Table 2**). The most common reason for not selecting the locally produced food item was due to higher cost for 9 out of 12 of those items. The other reason for not selecting the locally produced item was that it was the wrong sized item (**Table 3**).

Table 1. Top 15 Missing Food Items by Jurisdiction, the Children's Healthy Living Food Cost Survey (March 2021)

Food	Alaska (N=4)[a]	American Samoa (N=6)[a]	CNMI (N=6)[a]	Guam (N=5)[a]	Hawai‘i (N=5)[a]	Total (N=26)[a]
	N[b] (%)	N[b] (%)	N[b] (%)	N[b] (%)	N[b] (%)	N[b] (%)
Chicken bouillon cubes (low sodium)	3 (75)	6 (100)	6 (100)	4 (80)	1 (20)	20 (77)
Beef, ground	0 (0)	6 (100)	6 (100)	3 (60)	0 (0)	15 (58)
Gelatin	0 (0)	5 (83)	3 (50)	5 (100)	1 (20)	14 (54)
Beans, baked	0 (0)	6 (100)	4 (67)	3 (60)	1 (20)	14 (54)
Cheese cottage	0 (0)	6 (100)	5 (83)	3 (60)	0 (0)	14 (54)
Molasses	0 (0)	6 (100)	6 (100)	2 (40)	0 (0)	14 (54)
Turkey breast	0 (0)	6 (100)	5 (83)	2 (40)	1 (20)	14 (54)
Turkey, ground	0 (0)	5 (83)	6 (100)	2 (40)	1 (20)	14 (54)
French or Italian bread	0 (0)	6 (100)	3 (50)	3 (60)	1 (20)	13 (50)
Fudgsicles	0 (0)	4 (67)	6 (100)	3 (60)	0 (0)	13 (50)
Noodles, yolk-free	0 (0)	6 (100)	4 (67)	2 (40)	1 (20)	13 (50)
Bagels	0 (0)	6 (100)	2 (22)	2 (40)	1 (20)	11 (42)
Frozen orange juice	0 (0)	5 (83)	4 (67)	2 (40)	0 (0)	11 (42)
Cheese mozzarella	0 (0)	6 (100)	3 (50)	1 (20)	0 (0)	10 (38)
Dinner rolls	0 (0)	3 (50)	4 (67)	2 (40)	0 (0)	9 (35)

[a] number of communities surveyed in each jurisdiction; [b] number of communities in jurisdiction with missing food item

Table 2. Locally Produced Available[a] and Chosen[b] for Survey by Food Group Category Across Jurisdictions, the Children's Healthy Living Food Cost Survey (March 2021)

Food Group Category	Alaska		American Samoa		CNMI		Guam		Hawai'i	
	Locally Produced	Chosen	Locally Produced	Chosen	Locally Produced	Chosen	Locally Produced	Chosen	Locally Produced	Chosen
	N	N	N	N	N	N	N	N	N	N
Fruits (N=8)	0	0	1	1	2	2	1	1	2	2
Vegetables (N=14)	2	2	2	1	5	5	1	1	4	3
Grains (N=15)	6	5	4	4	5	5	5	5	6	6
Dairy (N=6)	2	0	0	0	0	0	2	0	2	2
Meats (N=12)	2	0	1	1	0	0	0	0	6	5
Fats & Oils (N=4)	0	0	0	0	0	0	0	0	0	0
Sugars (N=9)	0	0	0	0	0	0	0	0	4	3
Spices (N=19)	0	0	0	0	0	0	0	0	3	2
Total (N=87)	12	7	8	7	12	12	9	7	27	23

[a] number of locally produced items available; [b] number of available locally produced items chosen as best option

Table 3. Locally Produced Survey Food Items Not Selected and Reason for Not Selecting, by Jurisdiction, the Children's Healthy Living Food Cost Survey (March 2021)

Jurisdiction	Cost[a] (Higher Price)	Wrong Size[b]
Alaska (N=5)	4	1
American Samoa (N=1)	Reason not provided	Reason not provided
CNMI (N=0)	0	0
Guam (N=2)	2	0
Hawai'i (N=4)	3	1
Total (N=12)	9	2

[a] locally produced item cost was higher than another available item; [b] locally produced item did not meet the specific size stated in the CFSAT protocol

Discussion

The variation in the number of missing food items across stores in the CHL jurisdictions can be attributed to several factors, including long food supply chains, shipping challenges, and population size.[1-3] Alaska and Hawai'i had the least number of missing items and have the largest populations and closest distance to the contiguous US.[1,3] Whereas, American Samoa, Guam, and CNMI are geographically further from the contiguous US and have considerably smaller populations.[1] Food items must be transported by sea or air over considerable distances which can lead to delays and increased costs. Perishable goods, in particular, may suffer from spoilage during transit. This could cause logistical challenges, higher shipping costs, and limited access to reliable transportation options which may further hinder the timely delivery of food items.[11] Specific characteristics of some of the food items (eg, low-sodium chicken bouillon cubes) on the CHL FCS were not commonly available in the jurisdictions.

Food items in the CHL FCS reflect what was commonly consumed in the contiguous US based on the 1999 USDA TFP.[9] The USAPR populations have unique cultures and dietary preferences[12] with specific culinary traditions that may not match the CHL FCS food items. In addition, the USAPR's dietary patterns were not reflected in the formulation of the TFP;[4] therefore, the CHL FCS may not be applicable in the context of culturally diverse USAPR. As the TFP estimates the cost of a healthy, budget-conscious diet, a TFP tailored specifically to the jurisdictions in USAPR could provide more accurate and relevant findings.

Additionally, a tailored TFP that incorporates locally produced food items would provide a more complete assessment of what is available in these jurisdictions. The current CHL FCS may not fully reflect local food availability, as the survey was designed based on the food systems of another region. For example, the tropical climate in American Samoa, CNMI, Guam, and Hawai'i and the short growing season in Alaska, limit the

cultivation of certain fresh food items included in the CHL FCS (eg, apples, peaches and other temperate climate foods), while other locally grown fruits and vegetables better suited to the region's environment are not recognized.[1] Other food items require manufacturing capabilities that are limited in the region. The region's geographic isolation, limited manufacturing capabilities, scarce production materials, and high production costs influence the production of local foods.[13] Transportation challenges also affect the movement of goods from various sources including farms and ports to food outlets. These challenges stem from the unique geography and infrastructure limitations of the region.[1] Additionally, the food items do not reflect the dietary patterns of the specific population groups in the region.[12,14] The inclusion of traditional and locally grown food items in nutritional guidance would allow for local food substitution reducing the amount of imports and the dependency on global supply chains, which can be disrupted by natural disasters, political instability, or pandemics.[15]

Food preferences are shaped by a variety of factors, including consumer demand, which is influenced by convenience foods, assimilated tastes, cultural and social norms, and food item costs.[16] One result of the lack of nutritional data in the region is the lack of nutrient information for local foods, which may prevent these locally produced foods from being eligible for inclusion in federal food assistance programs, such as the Special Supplemental Nutrition Program for Women, Infants and Children (WIC).[12] The eligibility of food items in these programs influence the types of food items available in stores. Retailers that participate in WIC programs must meet specific criteria, prioritizing shelf space for WIC-approved foods, such as dairy products and whole grains, which have limited production in the region.[17] This leaves less shelf space for locally produced items.

Due to the high prevalence of household food insecurity[18] and lower quality of food outlets in the region,[19] documenting the availability of local foods and describing factors influencing food access can lead to the creation of a more equitable, sustainable, and culturally relevant food system. A culturally relevant food system would strengthen food security by preserving traditional food practices which are adapted to local ecosystems and more resilient to climate change.[20] Additionally, it would enhance community health and identity by providing culturally familiar and nutritious foods fostering a deeper connection to heritage and place.[21]

This study has several limitations that should be considered when interpreting its findings. Firstly, the CHL FCS was based on the CFSAT, which contains similar foods to those utilized in the USDA's 1999 TFP, which may not accurately reflect contemporary dietary patterns and food prices. USDA recently updated the TFP food items in 2021.[6,22] However, the updated TFP does not include food consumption data from the USAPR. Secondly, the study was conducted in March and seasonality could have influenced the availability and cost of certain food items, potentially leading to variations in the data throughout the year. Additionally, the type of stores where data was collected may not represent the entire spectrum of food sources in the studied communities. Locally produced foods may be accessed through farmers markets/stands, family farms, or produce grown at home. Thus, the CHL FCS may not have captured the availability of some locally produced food items. Finally, the data was only collected in selected communities and variations in food access and availability may exist in other areas not included in the study, potentially affecting the overall representativeness of the findings.

Conclusion

The geographic isolation and relatively small populations of the USAPR affects the availability of CHL FCS food items and may not capture locally produced foods in the region. The food items surveyed by CHL were based on contiguous US food items and may not reflect food items purchased and consumed in the USAPR potentially impacting the accuracy of the results of this study. The inclusion of the region's cultural and dietary practices in nutritional guidance is crucial in preserving local food cultures, the production and consumption of local foods and the understanding of their benefits to the health of the USAPR population.

Conflict of Interest

None of the authors identify a conflict of interest.

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Meeting Hawai‘i’s Mental Health Needs: The Psychiatric Mental Health Nurse Practitioner Program

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The Spotlight on Nursing is a recurring column from the University of Hawai‘i at Mānoa School of Nursing and Dental Hygiene (SONDH). It is edited by Holly B. Fontenot PhD, APRN, WHNP-BC, FAAN, FNAP; Associate Dean for Research, Professor, and Frances A. Matsuda Chair in Women’s Health for SONDH, and HJH&SW Contributing Editor; and Joanne R. Loos PhD, Science Writer for SONDH.

Abbreviations

DNP = Doctor of Nursing Practice
PMHNP = Psychiatric Mental Health Nurse Practitioner
UH = University of Hawai‘i

Nearly 50 million people in the United States (US) (19.9% of adults) report having a mental illness.[1] In Hawai‘i, 17.5% of adults have a diagnosed mental illness, which ranks as the fourth lowest in the US.[1] Although the state ranks among the lowest, it has the highest prevalence of adults who have received treatment for their disorder (67.1%).[1] Among children in Hawai‘i, 14.2% reported suffering from at least 1 major depressive episode in the past year, compared to 15.1% nation-ally.[1] Nationally, 59.8% of youth with major depression do not receive any mental health treatment, and 14% of adults report unmet needs for acute mental illness, citing: (1) no or lack of insurance, (2) lack of mental health workforce, (3) lack of treatment types, (4) fragmented health care systems between mental health and primary care, and (5) lack of means to cover costs of services.[1] The problem is exacerbated as Hawai‘i and the nation are experiencing a shortage of mental health provid-ers at a time when the need for mental health services is more severe than ever.

The US Health Resources and Services Administration projected a shortage of at least 250 000 mental health providers nationally by 2025.[2] Two-thirds of primary care physicians report that they could not get outpatient mental health services for their patients—a rate that was at least twice as high as that for other services.[3] The Hawai‘i Physician Workforce Report 2023 has identified shortages for adult and child psychiatry services, 42% and 45% respectively.[4] Rural Hawaiian islands are more severely impacted with the islands of Hawai‘i, Kaua‘i, and Maui experiencing shortages of greater than 70% for some mental health services.[4]

The Psychiatric Mental Health Nurse Practitioner, an Option to Enhance Services

In August 2022, the University of Hawai‘i (UH) at Mānoa School of Nursing and Dental Hygiene conducted a needs assessment related to starting a Psychiatric Mental Health Nurse Practitioner (PMHNP) program as a new nurse practitioner specialty option for the Doctor in Nursing Practice (DNP) degree program. The needs assessment included student and labor market demand and an analysis of potential competitor programs. Findings indicated that there was a strong labor market for PMHNPs, attributed in part to a shortage of physicians who specialize as psychiatrists. Further noted was the confirmed shortage of mental health providers in rural areas. There is a growing number of PMHNP programs across the US, yet the far western regions of the US continue to lack robust programing. This suggested that there would be student demand and community need for this type of program. Finally, the majority (70%) of benchmarked competitors use hybrid modalities to deliver their programs, with none offering 100% in-person formats, which may strengthen culturally informed curriculum and clinical experiences.

Advance practice nurses who specialized in mental health were some of the earliest to work in advanced practice roles in the US, and programs have existed since the 1950s.[5] In the beginning, the first advanced practice nurses were certified as psychiatric clinical nurse specialists at Rutgers University with support from a grant from the National Institute of Mental Health.[6] Over time, the role of the psychiatric clinical nurse specialist diversified, specialized, and expanded in competencies and scope. Then in 2000, the American Nurses Credentialing Center developed the first PMHNP board certification to meet the public health needs,

while standardizing certification based upon the Consensus Model for Advanced Practice Nurse Regulation: Licensure, Accreditation, Certification & Education.[7] Nationally, in 2011 the Institute of Medicine recommended and highlighted the importance of training highly competent nurses to meet the current health care demands, including mental health care de-mands.[8] Advanced practice nurses/nurse practitioners practice nursing at the full scope of their education to meet the needs of the communities for which they serve, much of which is in rural settings. They are an asset to the inter professional health care infrastructure. Empowered nurses lead change and advance health for the well-being of our society.[8]

The New Psychiatric Mental Health Nurse Practitioner Program at UH Mānoa

The new PMHNP specialty program's goals, aligned with national standards, are to develop highly competent nurse practitioners prepared to meet the needs of Hawai'i's growing mental health crisis, who understand the unique needs and cultures of Hawai'i. At program completion, students are eligible to sit for national certification as PMHNPs. They will possess a diverse skill set, with competencies to improve outcomes by providing individual and group-based therapy, diagnosis, and treatment for those with mental illness and disease, including prescribing and managing medications used for mental health disorders. They also have the expertise to meet the constantly evolving and complex demands of the health care environ-ment, utilizing evidence-based approaches and frameworks to enhance the quality of care and patient safety at both individual and organizational levels.[9]

Meeting Hawai'i's Mental Health Needs

Expanding Hawai'i's mental health provider network presents several challenges, including navigating the state's high cost of living, diverse patient population, difficulty with re-location from out of state, and lack of accessible resources. To address this, the school of nursing emphasizes education of local nurses to become advanced practice providers, and the program provides culturally tailored education and community-driven approaches throughout the curriculum, simulation learning experiences, clinical learning sites, interprofessional experi-ences, and telehealth.

Simulation learning experiences, developed by subject matter experts, include topics such as houselessness,[10] disaster after-math training,[11] management of depression, and end-of-life discussions,[12] preparing students to manage care within diverse complex situations. The clinical learning sites across the state, including those in rural areas, allow the students to develop skills, competencies, and confidence within their local com-munities. As comorbidity and clinical complexity increases, interprofessional care is essential for positive clinical outcomes. Interprofessional education provides all health care students with the opportunities to collaborate with various professions to provide high-quality, team-based care. The School of Nurs-ing and Dental Hygiene is an active participant in the Hawai'i Interprofessional Education Committee, ensuring students have opportunities in simulation and/or clinical to practice interprofessional skills, which is rooted in the TeamSTEPPS (Team Strategies and Tools to Enhance Performance and Patient Safety) evidence-based model for teamwork.[13]

With provider shortages up to 70% in rural areas, access to care via telehealth is an essential skill set for improving access to mental health care across Hawai'i. Telehealth is a valuable tool. However, it adds layers of complexity to clinical practice. For instance, in order to offer telehealth, providers must be compe-tent in safety, communication, data collection, technology, and ethics. To address this need, integrated telehealth into simula-tion and clinical education is included in the curriculum,[14–16] ensuring that graduates are well-equipped to meet the needs of our community.

Program Highlights for Prospective Students

Designed for working students: A hybrid program with course offerings aimed to limit campus days to once a week, in blocks and evenings to support work-school-life balance.
Career satisfaction: Preparation at the highest clinical doctoral level of nursing practice to improve patient outcomes with greater autonomy and leadership potential in a variety of settings to meet professional goals.
Commitment to student success: Ongoing guidance and resources to support success, including 1:1 advising, clinical placement coordination, mentorship and guidance towards entry into practice.
Improve mental health and make a difference: An innovative curriculum designed and delivered by distinguished faculty with clinical practice expertise to improve access and quality of mental health care to diverse populations.

Next Steps and Conclusion

The School of Nursing and Dental Hygiene launched the first cohort of the PMHNP program in Fall Semester 2024, with expected graduation with a DNP in May 2027. The program is designed to build the next generation of nurse practitioners skilled in provision of mental health care in a collaborative environment alongside other DNP students who are studying to become Family Nurse Practitioners and Adult Geriatric Nurse Practitioners. As the program advances, students will engage with professionals from other disciplines at various practice sites, expanding their competencies to provide mental health care across the lifespan and health care settings.

The School of Nursing and Dental Hygiene is committed to continuously improving its innovative, culturally informed, and evidence-based curriculum and practices. Students and stakeholders participate in ongoing program evaluation and

reflection to ensure continuous quality improvement and the development of new pedagogy and programing. Upon program completion, students can apply for PMHNP board certification through the American Academy of Nurse Practitioners or the American Nurses Credentialing Center. After earning board certification, graduates apply for state licensure to practice as an advanced practice nurse with prescriptive authority. In Hawai‘i, nurse practitioners have full practice authority, allowing them to transition into the workforce and immediately help address the shortage of mental health providers. PMHNPs are well-positioned to help address the workforce shortage and drive crucial changes needed in Hawai‘i, addressing mental health inequities.

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