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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.

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HAWAI'I JOURNAL WATCH

KAREN ROWAN MS

Highlights of recent research from the University of Hawai'i and the Hawai'i State Department of Health

HOW THE AFFORDABLE CARE ACT AFFECTED SUBSTANCE USE DISORDER TREATMENT PROGRAMS

The Affordable Care Act (ACA) required state Medicaid plans to expand coverage of treatments for substance use disorders (SUDs). Researchers including Clifford Bersamira PhD, of the Myron B. Thompson School of Social Work, collected and analyzed data from the National Drug Abuse Treatment System Survey and compared enrollment in SUD treatment programs before and after the ACA took effect. The percentage of patients in SUD treatment programs nationally who were insured by Medicaid rose from 26% to 38% after the ACA was implemented. The percentage of patients in these programs who had no insurance fell from 38% to 23%. The findings show that Medicaid increases insurance coverage for people enrolled in specialty SUD treatment, the researchers wrote. The study (PubMed ID: [31202283](#)) is published in the *Journal of Substance Abuse Treatment*.

DISPARITIES IN DIABETES RATES IN HAWAI'I

Differences in the prevalence of diabetes among Hawai'i's major ethnic groups appear by age 35, and increase rapidly with age. Researchers led by Olivia Uchima MA, with the Office of Public Health Studies, looked at data gathered in the Hawai'i Behavioral Risk Factor Surveillance System. Native Hawaiians and Other Pacific Islanders and Filipinos had higher rates of diabetes than Japanese, Chinese, and whites in Hawai'i. Public health efforts should promote healthy lifestyle behaviors and should be aimed at people in their early adult years, especially for low-income groups, the researchers concluded. The findings (PubMed ID: [30789820](#)) were published in *Preventing Chronic Disease*.

DRUG INTERACTIONS IN ELECTRONIC DATABASES

Drug-drug interactions (DDIs) can cause treatments to fail, which can result in morbidity and mortality. Electronic reference databases are useful tools to detect and prevent potential DDIs, increasing patient safety. Researchers including Supakit Wongwiwatthanakit PhD, PharmD, of the Daniel K. Inouye College of Pharmacy, compared the drug interactions listed in two online databases for 84 drugs used to treat patients with metabolic syndrome. Results showed Drugs.com reported interactions for 1122 pairs of the drugs, while Micromedex reported interactions for 724 pairs. The study also found the two databases had a significant discrepancy in reporting the severity of DDIs. The Drugs.com database had a higher sensitivity to detect potential DDIs, but Micromedex provided more informative documentation about DDI severity. Pharmacists should use at least two databases to evaluate interactions, the researchers concluded. The study (PubMed ID: [31725785](#)) is published in *PLoS ONE*.

MEDIATORS OF PHYSICAL ACTIVITY IN POST-PARTUM WOMEN

For post-partum women, having social support from family and friends may be a key factor in increasing physical activity. Researchers led by Cheryl Albright PhD, MPH, of the School of Nursing and Dental Hygiene, explored mediators of physical activity over a 12-month randomized controlled trial. The trial was designed to increase physical activity in 311 postpartum women in Hawai'i using a website and telephone counseling tailored to new mothers' lifestyles. The results showed significantly higher increases in physical activity during the second 6 months of the study among the women who had increases in their social support in the first 6 months. Social support enhanced participants' ability to integrate exercise into their daily routines. New mothers benefited from learning how to enlist social support for exercise, the researchers concluded. The study is published in the *Translational Journal of the ACSM*.

GENETIC LINKS TO PREECLAMPSIA

The causes of preeclampsia, a condition that involves high blood pressure and is associated with maternal deaths and stillbirths, remain unclear, but a genetic link has been suggested. Researchers including Paula Benny PhD, of the UH Cancer Center, tested DNA samples from 31 women with early-onset preeclampsia and a control group of 29 women without preeclampsia who delivered healthy newborns at Kapi'olani Medical Center for Women and Children between 2005 and 2011. Results revealed 68 genes that were significantly associated with early-onset preeclampsia. The study was the first to examine the genetics of this condition in a largely Asian and Native Hawaiian/Other Pacific Islander population. More research is needed to examine the possible roles of these genetic associations in the development of early-onset preeclampsia, the researchers concluded. The study (PubMed ID: [31557190](#)) is published in *PLoS ONE*.

SURVIVORSHIP IN LIVER CANCER

Hepatocellular carcinoma (HCC), a cancer of the liver, is a leading cause of cancer deaths, and the 5-year survival rate is dismal. Researchers led by Linda Wong MD, of the John A. Burns School of Medicine, utilized a database of 1374 HCC patients in Hawai'i. They identified 70 patients who had survived 10 years with HCC and compared them with 164 patients who had undergone either a liver resection (removal of a portion of the liver) or transplant (replacement of whole liver) and had died within 10 years. They found that the majority of 10-year survivors had also undergone either a liver resection or a transplant. After the adjustment of several factors, the study showed the 10-year survivors were younger and less likely to have diabetes. Patients who underwent transplants had a lower rate of cancer recurrence compared to the liver resection group. The only predictor of not surviving 10 years after a transplant was a recurrence of the cancer. The study (PubMed ID: [31701016](#)) is published in *Hepatology Research*.

Iatrogenic Implantation of Cancer Cells During Surgery

Eric Gresham MD and Fereydoun Don Parsa MD, FACS

Abstract

In the late 1800s, the concept of iatrogenic implantation of cancer cells during surgery was put forth. The most dramatic example is a recurrence in a donor graft site, which is often distant to the primary site of excision. This eliminates the possibility of incomplete removal as the etiology of recurrence. However, in addition to direct transplantation to the graft site via gloves or instruments, several other possibilities exist, including de novo lesions of squamous cell carcinoma in the graft, as well as systemic metastases. This article reviews 15 published case reports of cancer recurrence in graft donor sites in which the authors considered seeding via gloves or instruments. Viewing these cases in the context of a 2018 study demonstrates the varying opinions of surgeons on the possibility of cancer seeding. This article strongly advises the changing of gloves and instruments following resection of any suspicious or established cancerous tumors.

Keywords

cancer seeding, graft site, iatrogenic, sterile field, tumor implantation

Abbreviation

SCC = *squamous cell carcinoma*

Introduction

In 1896, Lack first penned the consideration that cancers may disseminate iatrogenically via “direct transplantation, as distinguished from dissemination by means of the blood and lymph channels.”¹ This was an important progression from Gerster in 1885, who was the first to caution surgeons on the risk of iatrogenic dissemination of cancer. Gerster’s focus, however, was on the avoidance of massaging tumors, resulting in tumor cells “propelled through the lymphatics and veins into the general circulation.”² Lack’s belief was echoed by Ryall in 1907.³ Over a century later further clinical observations were made of this phenomena. In 1954, Ackerman and Wheat called for surgeons to change instruments, gloves, and drapes in cases requiring grafting for malignant tumors.⁴ However, in 2018, Berger-Richardson, et al, found in a survey of 351 Canadian general surgeons, only 52% changed gloves during cancer excisions to prevent seeding. When asked about beliefs, 58% thought it was “possible or probable” (vs unlikely, definitely not, definitely) that gloves could harbor malignant cells, but approximately 57% thought it “unlikely” they could lead to locoregional or wound recurrence.⁵ Surgeons are often faced with the need for concurrent incisional or excisional biopsies of two or more lesions from different sites in the same individual that are suspicious of cancer.

As seen by the opinions expressed, there is no standard of care dictating the changing of gloves and instruments. This review aims to answer the question whether, in the literature, there is evidence of patients undergoing cancer excisions where iatrogenic implantation of cancer cells via gloves or instruments has occurred. To isolate these instances from recurrence due to imperfect removal, this literature review will focus on known cases of iatrogenic implantation of graft sites, as they present the most compelling example of iatrogenic seeding and make the case for the consistent practice of changing gloves and instruments following the excision of a specimen suspected to be cancerous.

Methods

A literature review was conducted using PubMed and the University of Hawai‘i at Mānoa Library’s OneSearch from January 15, 2019 to April 14, 2019. OneSearch is a tool used to search Primo Central Index, Hawai‘i Pacific Journal Index, Scholarspace, and eVols. PubMed search terms in “all fields” included “seeding cancer to skin graft site,” “tumor seeding gloves,” “iatrogenic tumor implantation,” and “iatrogenic tumor seeding.” Sources found in PubMed also provided references. In addition, searching for referenced articles via OneSearch and Google provided additional journal articles. No date range was placed on the search, in order to find both the earliest referenced studies as well as the most recent.

Case Reports

In 1986, Carr and Gilbert described an early example of iatrogenic tumor implantation to a graft donor site. It occurred at the temporalis muscle flap donor site from squamous cell carcinoma (SCC) excised from the right retromolar fossa. Carr and Gilbert postulated the implantation most likely occurred by introducing an orally contaminated glove or instrument when the flap was transferred to the mouth by passing it through the infratemporal fossa, or during the raising of the flap. Lymphatic drainage of the tumor was deemed unlikely as there was no known drainage from the mouth to the implanted area. Incomplete removal of the tumor was not considered, due to the distance from the primary site.⁶

In 1988, Nielson, et al, described a patient presenting with SCC on the right ring finger, treated with wide excision and a split thickness skin graft from the right thigh. At 3 months follow up, the patient presented with SCC on the margin of the graft

donor site. The authors cited the possibility of the SCC on the graft being a new primary lesion, due to neoplastic change secondary to the scarring.⁷

While proving iatrogenic implantation of SCC in a skin graft is an arduous task, given the propensity for *de novo* lesions, the examination of other tumors can eliminate that possibility. In 2001, Sadahira et al. encountered a patient with evidence of a recurrent malignant meningioma in the abdominal fat pad, which had been used to pack the orbital defect secondary to curettage of the tumor. Although the authors had not conducted the surgery, it was suspected that iatrogenic implantation occurred based on the history and histological review.⁸

In 2003, Hoopmann, et al, described what they believed to be the first ever recurrence of breast cancer in a musculocutaneous flap. The patient presented with a mass in the right upper outer quadrant of the left breast, which, when excised, was found to have positive lymph nodes as well as metastasis to the bone. Over a year later, the patient developed pain in the donor site (latissimus dorsi flap), and pathologically similar cancer was found. The authors noted the inevitability of contact between the cancer and the graft site due to the “extensive axillary involvement with infiltration into the surrounding tissue,” and stated that this case should serve as a reminder for “standardized operative safety measures (eg, the obligatory change of gloves and instruments after tumor excision).”⁹

Hussain, et al, published a case report with convincing evidence of iatrogenic implantation with SCC in 2011. Despite adhering to glove and instrument changes, they noted the most likely cause was the use of the same hollow needle to give anesthetic in the tumor area (right hand) as the donor site (right thigh). Other possibilities given included contamination of the graft harvesting equipment with tumor cells, a new primary lesion, or systemic spread.¹⁰ In 2012, Morrill and Khandwala also had a case of possible iatrogenic SCC implantation. However, they believed the most likely cause to be primary. This reasoning was supported by primary SCC in the cases of grafts used for burns, describing the increased risk as due to the donor site being an “area of inflammation with fibroblast and vascular proliferation. The dividing cells are more susceptible to carcinogenesis.”¹¹

Also in 2012, Wright, et al, reported a case with haematogenous spread of tumor cells as the most likely cause for metastasis. The patient underwent facial reconstruction for right post-auricular SCC with a right anterolateral thigh free flap, which required a split thickness skin graft from the left thigh. Approximately 6 months later, the patient demonstrated SCC nodules on the left thigh donor site. The authors believed they maintained sterile technique between all fields, and cited a case report of haematogenous spread of tumor cells to the contralateral thigh donor site in melanoma (the skin graft was delayed versus the excision thus excluding implantation) as evidence of the most likely mode in their case. However, they did not rule out “iat-

rogenic mechanical spread at time of surgery,” but only due to the unlikely risk of airborne spread, as detected via “viable melanoma cells [sic] in electrocautery plume in mice.”¹²

In 2015, Pai, et al, described a case of soft tissue sarcoma in which iatrogenic implantation was also the most likely mechanism. The patient was found to have a sarcoma on the skin graft of his left leg. On further investigation, it was ascertained 8 years ago he underwent excision and radiation for sarcoma on the right leg, and workup for metastasis was negative. This led the authors to conclude there were 3 possible mechanisms: implantation, a second primary tumor, or haematogenous spread. They believed implantation was the most likely cause given that there were no other sites of metastasis. Pai, et al, went on to recommend the following measures when using grafts in oncologic reconstructions: “A common draping for the primary tumor and flap donor site should be avoided. Ulcerated or fungating tumors should be sealed with impermeable skin barriers to avoid tumor spillage in the operative field. Harvesting of the flap should be started only after resection of the primary is complete to avoid cross contamination. Change of gloves is mandatory for all the surgeons and nurses after resection of the primary and before reconstruction begins. Separate surgical trolley with a separate set of instruments including cautery tip should be used for both the procedures. Hollow needles if used for infiltration during primary surgery should not be reused at flap donor sites. Proper irrigation of the operative field at the end of resection decreases chances of implantation of the tumor cells. Gentle handling of the tissues so that tumor cell dissemination can be minimized particularly in the case of necrotic tumors.”¹³

Discussion

Despite the case reports described above and listed in Table 1, there is no general consensus for recommendation of instrument/glove changes following cancer excision.⁵ In addition, some authors made reference to specific gown and draping practices for maintaining separation between tumor and graft sites, while others did not.^{4,9,13} These are supplementary to standard surgical protocols such as excision into negative margins, en-bloc resection to avoid local recurrence, and avoidance of tumor spillage as recommended, for example, in colon cancer removal.¹⁴ The case reports, as summarized in Table 1, communicate the potential of iatrogenic spread via gloves and instruments. If this is possible to carry over to a distant site, via eg, gloves, there is no reason to believe this low risk of seeding is not also present at the excision site. However, Table 1 also demonstrates the various potential mechanisms of cancer spread, and that often the reason for recurrence is unclear. Perhaps due to this uncertainty, Berger-Richardson, et al, called for more research to ascertain whether viable cancer cells are detectable on gloves and instruments.⁵ However, as cited by Berger-Richardson, et al, Curran, et al, in 1993 had already demonstrated “squamous epithelial debris, consistent with squamous cell carcinoma” was found in both glove and instrument washings following

Table 1. Summary of Published Case Reports in Chronological Order Documenting Possible Iatrogenic Implantation of Cancer Cells in Graft Donor Sites, with 10 of 15 Papers Listing Iatrogenic Implantation as One of the Most Likely Proposed Mechanisms.

Year	Authors	Cancer Site	Cancer Type	Donor Site	Proposed Most Likely Mechanism
1986	Carr, et al.	Right retromolar fossa	SCC	Right temporalis muscle flap	Iatrogenic implantation
1988	Neilson, et al.	Right finger	SCC	Right thigh	De novo
1995	Cole Jr and Sindelar	Right tibia	Osteosarcoma	Left iliac crest	Iatrogenic implantation
1996	Yip, et al.	Left iliac crest	Osteosarcoma	Left fibula	Haematogenous spread
2000	Hughes, et al.	Right popliteal artery	Soft tissue sarcoma	Left saphenous vein	Iatrogenic implantation
2000	Dias, et al.	Left distal femur	Malignant fibrous histiocytoma	Left iliac crest	Iatrogenic implantation or haematogenous spread
2001	Sadahira, et al.	Right orbit	Meningioma	Abdominal wall	Iatrogenic implantation
2003	Singh, et al.	Right humerus	Osteosarcoma	Left iliac crest	Iatrogenic implantation or haematogenous spread
2003	Hoopmann, et al.	Left breast	Adenocarcinoma	Left latissimus dorsi	Iatrogenic inoculation
2010	May, et al.	Periorbital	Keratoacanthoma	Thigh (unspecified)	De novo
2011	Hussain, et al.	Right hand	SCC	Right thigh	Iatrogenic implantation
2012	Wright, et al.	Right post-auricular region	SCC	Left thigh	Haematogenous spread
2012	Morritt, et al.	Left lower leg	SCC	Left thigh	Systemic spread
2015	Pai, et al.	Right leg	Soft tissue Sarcoma	Left leg	Iatrogenic implantation
2017	Aloraifi, et al.	Left cheek	Merkel cell carcinoma	Right supraclavicular area	Iatrogenic implantation or viral recurrence

surgeries for SCC in the head and neck.¹⁵ This review demonstrates conclusive evidence that while changing gloves and instruments following cancer excision may not fully protect versus the risk of tumor implantation, it should be considered as the standard of care.

Conclusion

Although consensus does not exist, based on multiple case reports and observations, it is strongly advisable to change gloves and instruments following resection of any suspicious or established cancerous tumors.^{9,13}

Conflict of Interest

None of the authors identify any conflicts of interest.

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An Evaluation of Infertility Among Women in the Republic of Palau, 2016

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Abstract

Fertility challenges are a personal and important part of a woman's reproductive health and are associated with health and lifestyle factors. Limited data exist on infertility among women in Palau. We describe the lifetime prevalence of self-reported infertility in a nationally representative sample of women in Palau and investigate the association between tobacco and/or betel nut use and infertility. During May-December 2016, a population-based survey of noncommunicable diseases was conducted in Palau using a geographically stratified random sample of households (N=2409). Men and women ≥18 years of age were chosen randomly from each selected household. The prevalence of a self-reported lifetime episode of infertility (having tried unsuccessfully to become pregnant for ≥12 months) was evaluated among 874 women aged ≥18 years by key health and lifestyle factors. Prevalence ratios (PR) and 95% confidence intervals (CI) were calculated. Of 315 women who ever tried to become pregnant, 39.7% (95% CI: 34.2%, 45.3%) reported a lifetime episode of infertility. Prevalence was higher in women of Palauan vs other ethnicity (PR=1.6, 95% CI: 1.1, 2.3), those who self-reported poor/hot good vs. excellent/very good health status (PR=2.1, 95% CI: 1.4, 3.3), and those with a body mass index (BMI) ≥30 vs <30 (PR=1.7, 95% CI: 1.3, 2.2). Adjusted models showed that tobacco and/or betel nut users were almost twice as likely to report infertility versus non-users (PR=1.8, 95% CI: 1.3, 2.5). More research is needed to understand the infertility experiences of women in Palau and to promote lifestyle factors contributing to optimal reproductive health.

Keywords

Palau, infertility, tobacco, betel nut, obesity

Abbreviations

BMI = body mass index
CI = confidence interval
CT = Chlamydia trachomatis
LBW = low birth weight
NSFG = National Survey of Family Growth
PID = pelvic inflammatory disease
PR = prevalence ratio
STI = sexually transmitted infection

Introduction

The Republic of Palau is an island nation in the western Pacific Ocean with a population of approximately 18000 people.¹ Palau is 1 of 3 Pacific Island nations that have a Compact of Free Association with the United States, along with the Federated States of Micronesia and Republic of the Marshall Islands.² Similar

to other countries in the Pacific, Palau has a high prevalence of noncommunicable diseases, as well as a high prevalence of the known risk factors for noncommunicable disease, including unhealthy diet, physical inactivity, obesity, excessive alcohol consumption, and tobacco use.^{3,4}

An estimated 24.7% of adults in Palau smoke cigarettes daily, and many chew tobacco with betel nut, also known as areca nut.^{4,5} Betel nut chewing, common in countries in the Pacific Islands and South/Southeast Asia, generally consists of chewing betel nut along with slaked lime in a piece of a betel leaf. In Palau, betel nut chewing is more common than cigarette smoking, with an estimated 52.6% of adults regularly chewing betel nut (within the last 30 days), with 87% of those adding tobacco to the mixture.⁶⁻⁹ A higher proportion of women in Palau chew betel nut compared to men (55.1% vs 47.5%, respectively), both with and without tobacco.⁸ Chewing betel nut has psychoactive effects, including activation of the sympathetic nervous system to heighten alertness and reduce fatigue.^{9,10} This popular local custom is also known to have carcinogenic effects.^{6,11,12} Both tobacco and betel nut chewing are associated with oral cancers and both have been identified as public health problems in Palau.^{12,13} It is possible that the synergistic effect of combined tobacco and betel nut chewing may increase the risk of adverse carcinogenic outcomes.¹²

Tobacco and betel nut use can also affect a woman's reproductive health. Use of either during pregnancy can result in adverse outcomes, including impaired fetal growth, preterm delivery, low birth weight (LBW), cardiovascular problems, neonatal withdrawal symptoms, and infant mortality.^{14,21} Previous studies have also shown an association of tobacco use with infertility, and a meta-analysis of 12 studies found a 60% increased risk of infertility in women smokers vs. non-smokers of reproductive age.²²

Infertility, typically defined as the inability to conceive for ≥ 12 months of unprotected sexual intercourse, affects many women throughout the world.²³ Given that fertility declines steadily in women with age, some clinicians consider ≥6 months of unprotected sex without conception an episode of infertility in women aged ≥ 35 years.²⁴ In industrialized countries, about 15% of couples who try to conceive will fail to obtain a recognized

pregnancy.²⁵ Although infertility affects many women, there are limited data estimating its prevalence in many resource-constrained settings.

Despite the known adverse reproductive health outcomes associated with tobacco and betel nut use and the high prevalence of these lifestyle factors among women in Palau, no previous studies have examined the prevalence of and risk factors associated with infertility in these women. Therefore, the aim of this study was to estimate the lifetime prevalence of infertility in a nationally representative sample of women in Palau and investigate the association between tobacco and/or betel nut use and infertility.

Methods

Study Population and Design

We conducted a secondary data analysis using data from a population-based survey conducted in the Republic of Palau from May to December 2016 to assess noncommunicable diseases and associated risk factors. In the original survey, hereafter referred to as the Palau Hybrid Survey, 2409 households were surveyed. The household sample size was determined based on the most populated islands in Palau (Koror= 1592 households, Babeldaob= 704, Peleliu= 70, Angaur= 21, Kayangel= 11, Sonsorol= 6, Hathobei= 5). Households were randomly selected according to geographical stratification on 2 levels: island and state. Men and women aged ≥ 18 years were then randomly selected from each household for inclusion in the survey using the KISH selection method.²⁶ Individuals were eligible if they were able to comprehend either the English or Palauan language and provide consent. Due to the secondary data analysis nature of this study, the number of exclusions at each stage of sampling were unavailable to the author; however, most exclusions were due to vacant houses, with the true refusal rate being extremely low. Also, because of the large sample size relative to the total population of Palau (13.3% based on 2015 Census data) and the representativeness of the sample compared to the general population of Palau (the demographic distributions of the 2015 Census are relatively similar to the distributions of the survey sample demographics), these data were not weighted.^{1,8} See Supplemental Table 1 for a comparison of the selected sample to the total Palauan population based on 2015 Census data.⁸

Survey respondents answered questions about various health, dietary, and lifestyle factors, and had a range of physical and biochemical measurements taken. Modeled after the questions used in the National Health and Nutrition Examination Survey and the National Survey of Family Growth (NSFG),^{27,28} women who reported ever trying to become pregnant were asked “At any time, did you try for more than 12 months and not become pregnant?”; those answering “Yes” were considered to have had a lifetime episode of infertility.²⁹ We estimated the prevalence of

Table 1. Characteristics of Women Respondents of the Palau Hybrid Survey (n=874), Republic of Palau, 2016.

Characteristic	Sample Size	% (95% CI)
Age Group, in Years		
18-29	119	13.6 (11.4, 16.1)
30-39	159	18.2 (15.7, 20.9)
40-49	209	23.9 (21.1, 26.9)
50-59	196	22.4 (19.7, 25.3)
≥ 60	191	21.9 (19.2, 24.7)
Ethnicity^a		
Palauan	647	74.0 (71.0, 76.9)
Other	227	26.0 (23.1, 29.0)
General Health Status^b		
Poor/Not good	162	19.4 (16.8, 22.3)
Good/Fair/Okay	545	65.3 (61.9, 68.5)
Excellent/Very good	128	15.3 (13.0, 18.0)
Missing	39	
Body Mass Index		
<18.5	167	19.1 (16.6, 21.9)
18.5-24.9	169	19.3 (16.8, 22.1)
25-29.9	237	27.1 (24.2, 30.2)
≥ 30	301	34.5 (31.3, 37.7)
Lifetime Episode of Infertility^c		
Yes	125	39.7 (34.2, 45.3)
No	190	60.3 (54.7, 65.8)
Missing	559	
Any Tobacco Use^d		
Yes	466	53.3 (50.0, 56.7)
No	408	46.7 (43.3, 50.1)
Any Betel Nut Use^e		
Yes	481	55.1 (51.7, 58.4)
No	392	44.9 (41.6, 48.3)
Missing	1	
Any Tobacco and/or Betel Nut Use^{d,e}		
Tobacco use only	38	4.4 (3.1, 5.9)
Betel nut use only	53	6.1 (4.6, 7.9)
Both betel nut and tobacco use	428	49.0 (45.7, 52.4)
Neither	354	40.5 (37.3, 43.9)
Missing	1	

^a “Other” consists of Filipino or self-reported “Other” ethnicity.

^b General health status was based on self-report.

^c Of those who (1) responded “Yes” to ever having tried to get pregnant and (2) provided a response to the question “At any time, did you try for more than 12 months and not become pregnant?” Women answering “Yes” to the question “At any time, did you try for more than 12 months and not become pregnant?” were defined as having a self-reported lifetime episode of infertility.

^d Any tobacco use defined as reporting use of any of the following: cigarette sticks, e-cigarette, or betel nut with tobacco.

^e Any betel nut use defined as report of using betel nut, with or without tobacco.

Supplemental Table 1. Comparison of Palau Hybrid survey sample to 2015 Palauan population based on Census data. ^a		
	Survey Sample N=1768	2015 Census Data N=13,299
Gender		
Male	894 (51%)	7373 (55%)
Female	874 (49%)	5926 (45%)
Age Group		
18-24 years	143 (8%)	1660 (12%)
25-44 years	651 (37%)	5475 (41%)
45-64 years	754 (43%)	4874 (37%)
65+ years	220 (12%)	1289 (10%)
Ethnicity		
Palauan	1253 (71%)	(73%)*
Non-Palauan	515 (29%)	(27%)

*For all ages

self-reported infertility among women who had tried to become pregnant and investigated the association between tobacco and/or betel nut use and self-reported infertility. Data on pregnancy subsequent to an episode of infertility were not obtained.

Data Collection

Public health staff from the Palau Ministry of Health were trained to perform all interviews and measurements. Surveys were translated into Palauan and English and were performed in-person. The survey questions were taken from validated questionnaires, then piloted and modified as necessary for specificity to Palau (Supplemental Table 2). The translations into the Palauan language also underwent piloting. Information was collected on various sociodemographic (eg, age, ethnicity, education, marital status), health (eg, general health status, physical/dental exams, presence of noncommunicable diseases) and lifestyle (eg, tobacco, betel nut, and alcohol use, physical activity) characteristics and subsequent physical measurements were taken the following morning (including height and weight, fasting glucose, cholesterol, and blood pressure measurements). The temporality of lifestyle factors in relation to the episode of infertility was not assessed. Body mass index (BMI) was calculated using the measurements for height and weight. Data on reproductive outcomes or infectious diseases, including sexually transmitted infections (STIs) or their sequelae, were not collected. All data were collected electronically using a tablet and were uploaded weekly at the Palau Ministry of Health. The Palau Institutional Review Board approved and a Research Determination was received from the Centers for Disease Control and Prevention for this analysis.

Statistical Analysis

The prevalence of self-reported lifetime infertility and 95% confidence intervals (CIs) were estimated overall and by various

sociodemographic, health, and lifestyle characteristics, including age group (18-29, 30-39, 40-49, 50-59, ≥ 60 years), ethnicity (Palauan vs. other), self-reported general health status (excellent/very good, good/fair/okay, poor/not good), BMI (< 18.5 , $18.5-24.9$, $25-29.9$, ≥ 30), any tobacco use (use of cigarette sticks, e-cigarettes, or betel nut use with tobacco), any betel nut use (with or without tobacco), and any tobacco and/or betel nut use (tobacco use only, betel nut use only, both tobacco and betel nut use, or neither). Bivariate associations were estimated using prevalence ratios (PRs) and 95% CIs.

We estimated the association between any tobacco and/or betel nut use and infertility using a generalized linear model using a log link and assuming a binomial distribution adjusted for confounders. We first assessed for any effect measure modification by adding terms to the model specific to the interaction between tobacco and/or betel nut use and covariates, such as age, ethnicity, general health status, and BMI. Any interaction term with a P -value $\leq .05$ was considered an effect measure modifier. We then assessed for confounding for covariates with any tobacco and/or betel nut use through a change-in-estimate approach, with covariates changing the any tobacco/betel nut use and infertility association by $> 10\%$ remaining in the model. All analyses were conducted using SAS statistical software (version 9.4, SAS Institute, Cary, NC).

Results

A total of 1768 individuals aged ≥ 18 years completed the Palau Hybrid Survey; 874 were women. Of the women respondents, nearly half were ≥ 50 years of age (50-59 years: 22.4%, 95% CI: 19.7%, 25.3%; ≥ 60 years: 21.9%, 95% CI: 19.2%, 24.7%; Table 1) and the majority were of Palauan ethnicity (74.0%, 95% CI: 71.0%, 76.9%). Nearly 1 in 5 women respondents (19.4%, 95% CI: 16.8%, 22.3%) reported their general health status to be poor/not good, with the majority (65.3%, 95% CI: 61.9%, 68.5%) reporting to be of good/fair/okay health. More than one-third had a BMI defined as obese (BMI ≥ 30 ; 34.5%, 95% CI: 31.3%, 37.7%). Any tobacco and any betel nut use were both highly prevalent in this population, at 53.3% (95% CI: 50.0%, 56.7%) and 55.1% (95% CI: 51.7%, 58.4%), respectively, with 49.0% (95% CI: 45.7%, 52.4%) using both tobacco and betel nut.

Approximately 36.0% ($n=315$) of women reported that they had ever tried to become pregnant. Of these women, 39.7% (95% CI: 34.2%, 45.3%) reported a lifetime episode of infertility. Among women who had ever tried to become pregnant, those of Palauan ethnicity were significantly more likely to report an episode of infertility compared to those of "other" ethnicity (PR: 1.6; 95% CI: 1.1, 2.3; Table 2). Those reporting good/fair/okay health had nearly equal prevalence of self-reported infertility to those reporting excellent/very good health (PR: 1.1; 95% CI: 0.7, 1.7); however, those reporting poor/not good health had 2.1 times the prevalence of self-reported infertility

Supplemental Table 2. Palau Hybrid Survey Indicators. ⁸		
Variable	Source Question	Response Options
General Health	Would you say that your general health is...	Excellent, very good, good, fair or okay, poor or not good
Last doctor visit	About how long has it been since you last visited a medical provider for an annual checkup?	≤1 year, ≤2 years, ≤5 years, ≥5 years, never
Last dental visit	How long has it been since you last visited a dentist or a dental clinic for any reason?	≤1 year, ≤2 years, ≤5 years, ≥5 years, never
Teeth missing	How many of your permanent teeth have been removed because of tooth decay or gum disease?	1-5, ≥6 but not all, all, none
Body Mass Index category	Calculated by weight (kg) over height (cm) squared.	Underweight <18.5, normal 18.5-24.9, overweight 25-29.9, obese ≥30
Hypertension	Measured blood pressure and self-reported high blood pressure and medication status was used to categorize hypertension.	Hypertension = BP ≥140/90 and/or if they self-reported being diagnosed with hypertension and were taking medication for their hypertension
High blood sugar or diabetes	Measured fasting blood glucose and self-reported diagnosis of diabetes and medication status was used to categorize high blood sugar/diabetes.	Diabetes = fasting blood glucose ≥126mg/dL and/or self-report for diabetes and were on medication for their diabetes.
High Total Cholesterol	Measured total cholesterol was used.	Elevated cholesterol = total cholesterol ≥190mg/dL; high total cholesterol = total cholesterol ≥240mg/dL.
Low HDL Cholesterol	Measured HDL cholesterol was used.	Low HDL = HDL cholesterol <40mg/dL.
Diseases	Have you ever been told by a doctor that you have gout, arthritis, asthma, ulcer, other heart disease, heart disease, tuberculosis, depression, stroke, lung disease, cancer? (separate variables for each)	Yes or no
Infertility	At any time did you try for more than 12 months and not become pregnant?	Yes or no
Ectopic pregnancy	Were you ever told that you had an ectopic pregnancy (tubal pregnancy that resulted in a miscarriage)?	Yes or no
Pelvic Inflammatory Disease	Have you ever been treated with antibiotics for an infection in your fallopian tubes, womb, or ovaries, also called a pelvic infection, pelvic inflammatory disease, or P.I.D.?	Yes or no
Cigarette Use	During the past 30 days, on how many days did you smoke cigarettes?	0 days = no use; 1-29 days = some use; 30 days = everyday use
Quit cigarette use	Do you want to quit smoking cigarettes?	Yes or no
E-cigarette use	During the past 30 days, on how many days did you use E-Cigarettes or a personal vaporizer (PV), or electronic nicotine?	0 days = no use; 1-29 days = some use; 30 days = everyday use
Home 2nd hand smoke	During the past 7 days, on how many days did someone other than you smoke tobacco inside your home while you were at home?	0 days = no exposure; 1-7 days = some exposure
Work 2nd hand smoke	During the past 7 days, on how many days did you breathe tobacco smoke at your workplace from someone else other than you who was smoking tobacco?	0 days = no exposure; 1-7 days = some exposure
Vehicle 2nd hand smoke	During the past 7 days, on how many days did you ride in a vehicle where someone other than you was smoking tobacco?	0 days = no exposure; 1-7 days = some exposure
Any 2nd hand smoke exposure	Answered yes to any of the 2nd hand smoke questions	Yes or no
Betel nut use	During the past 30 days, on how many days did you chew betel nut?	0 days = no use; 1-29 days = some use; 30 days = everyday use
Use tobacco in betel nut use	What kind of tobacco do you most often add to your betel nut chew?	Cigarette Sticks, imported loose tobacco, locally grown tobacco, other type of tobacco
Quit betel nut use	Do you want to quit chewing betel nut with tobacco?	Yes or no
Alcohol consumption	During the past 30 days, on how many days did you have at least one standard drink of any alcohol?	0 days = no use; 1-29 days = some use; 30 days = everyday use
Binge alcohol frequency	During the past 30 days, how many days did you have (for men, ≥5 standard alcoholic drinks; for women ≥4 standard alcoholic drinks):	0 days = no binge, 1-29 days = some binge, 30 days = everyday binge
Fruit and vegetable consumption	Sum of usual daily fruit consumption and daily vegetable consumption.	<1 servings, 1-<3 servings, 3-<5 servings, ≥5 servings
Watching salt intake	Are you currently watching or reducing your sodium or salt intake?	Yes or no
Importance of lowering salt in diet	How important is lowering salt in your diet?	Very important, somewhat important, not at all important
Processed meat consumption	In a regular day, how many times do you eat processed meats? This does not include canned fish.	0 servings, 1 serving, ≥2 servings

Supplemental Table 2. Palau Hybrid Survey Indicators. ⁸ (Continued from Previous Page)		
Variable	Source Question	Response Options
Sugar-sweetened beverage consumption	In a regular day, how many sugary drinks do you drink? This does not include diet drinks made with artificial sweeteners.	0 servings, 1 serving, ≥2 servings
Physical activity level	Based on GPAQ questions and calculations which is a combination of how many weeks a person is vigorously or moderately active due to work, transportation, or recreational activities AND the total number of METs in a week. METs are commonly used in the analysis of physical activity. MET (Metabolic Equivalent): The ratio of the work metabolic rate to the resting metabolic rate. One MET is defined as 1 kcal/kg/hour and is equivalent to the energy cost of sitting quietly. A MET is also defined as oxygen uptake in ml/kg/min with one MET equal to the oxygen cost of sitting quietly, around 3.5 ml/kg/min.	<p>High-Level</p> <ul style="list-style-type: none"> • If vigorous PA due to work or leisure on more than 3 days a week and Total physical activity MET minutes per week is greater than or equal to 1500 • If moderate PA due to work or leisure on 7 days a week and Total physical activity MET minutes per week is greater than or equal to 3000 <p>Moderate-Level</p> <ul style="list-style-type: none"> • If vigorous PA due to work or leisure on more than 3 days a week that totals 60 or more minutes • If moderately PA due to work or leisure on 5 days a week that totals 150 or more minutes • If moderate PA due to work or leisure at least 5 days a week and Total physical activity MET minutes per week is greater than or equal to 600 <p>Low-Level</p> <ul style="list-style-type: none"> • Doesn't meet any of the above criteria
Colonoscopy screening	How long has it been since your last colonoscopy? (adults ≥50)	≤1 year, ≤2 years, ≤5 years, ≥5 years, never
Blood stool test	A blood stool test is a test that determines whether the stool contains blood. How long has it been since your last blood stool test? (adults ≥50)	≤1 year, ≤2 years, ≤5 years, ≥5 years, never
Mammogram screening	How long has it been since you had your last mammogram? (women 50-74)	≤1 year, ≤2 years, ≤5 years, ≥5 years, never
Clinical breast exam	A clinical breast exam is when a doctor, nurse, or other health professional feels the breasts for lumps. How long has it been since your last clinical breast exam?	≤1 year, ≤2 years, ≤5 years, ≥5 years, never
Pap smear screening	How long has it been since you had your last Pap test? (women 21-65)	≤1 year, ≤2 years, ≤5 years, ≥5 years, never
Drug use	During the past 30 days, report on how many days you used any of the following substance: prescription drugs, inhalants, LSD, heroin, marijuana. (separate variables for each)	No use = 0 days, use = ≥1 day
Perceptions of drugs as risky	How much do people risk harming themselves physically and in other ways when they engage in the following behaviors? Cigarettes, alcohol, marijuana, betel nut with tobacco, heroin, LSD, inhalants, prescription drugs without doctor's orders	Great risk, moderate, slight, no risk
Disapproval of drug use	How much do you approve or disapprove of the following substances? ≥1 pack of cigarettes per day, betel nut with tobacco everyday, marijuana ≥1 time a month, ≥2 alcohol beverages a day	Strongly disapprove, somewhat disapprove, don't disapprove (includes: approve, somewhat approve, and neither approve or disapprove)

compared to those reporting excellent/very good health (95% CI: 1.4, 3.3). Women with a BMI ≥30 were also significantly more likely to self-report infertility compared with women with a BMI <30 (PR: 1.7; 95% CI: 1.3, 2.2). Women with any tobacco and/or betel nut use were significantly more likely to self-report infertility compared with women using neither (PR: 2.0; 95% CI: 1.4, 2.7).

Among women who had ever tried to become pregnant, ethnicity, general health status, and BMI were also associated with any tobacco and/or betel nut use and were considered as possible confounders (Supplemental Table 3). Women of Palauan

ethnicity, those with a BMI ≥30, and those in good/fair/okay or poor/not good health (compared with excellent/very good health) were more likely to report any tobacco and/or betel nut use. In multivariate analysis, no covariate modified the association between any tobacco and/or betel nut use and infertility, and only BMI was identified to confound the association (age, ethnicity, and general health status were all not identified as confounders). Among women who had ever tried to become pregnant, those reporting any tobacco and/or betel nut use vs. those without had 1.8 times the prevalence of a self-reported lifetime episode of infertility, adjusting for BMI (adjusted PR: 1.8; 95% CI: 1.3, 2.5; Table 2).

Supplemental Table 3. Characteristics of Women Respondents of the Palau Hybrid Survey Associated with Any Tobacco and/or Betel Nut Use ^a (n=315) ^b , Republic of Palau, 2016.		
Characteristic	Prevalence (95% CI)	Prevalence Ratio (95% CI)
Age Group, in Years		
18-29	60.0 (40.6, 77.3)	Ref
30-39	47.9 (35.9, 60.1)	0.8 (0.5, 1.2)
40-49	58.0 (47.0, 68.4)	1.0 (0.7, 1.4)
50-59	65.3 (53.5, 76.0)	1.1 (0.8, 1.5)
≥60	52.9 (38.5, 67.1)	0.9 (0.6, 1.3)
Ethnicity^c		
Palauan	76.0 (69.8, 81.5)	6.5 (3.7, 11.4)
Other	11.7 (6.0, 20.0)	Ref
General Health Status^d		
Poor/Not good	81.5 (68.6, 90.8)	3.8 (2.2, 6.5)
Good/Fair/Okay	59.4 (52.2, 66.3)	2.8 (1.6, 4.7)
Excellent/Very good	21.6 (11.3, 35.3)	Ref
Body Mass Index		
≥30	75.2 (66.2, 82.9)	1.6 (1.3, 1.9)
<30	46.5 (39.5, 53.7)	Ref

^a Any tobacco and/or betel nut use defined as tobacco use only, betel nut use only, or both tobacco and betel nut use. ^b Of those who 1) responded "Yes" to ever having tried to get pregnant and 2) provided a response to the question "At any time, did you try for more than 12 months and not become pregnant?" (lifetime episode of infertility). ^c "Other" consists of Filipino or self-reported "Other" ethnicity. ^d General health status was based on self-report.

Table 2. Characteristics of Women Respondents of the Palau Hybrid Survey Associated with a Self-reported Lifetime Episode of Infertility (n=315) ^a , Republic of Palau, 2016.			
Characteristic	Prevalence (95% CI)	Prevalence Ratio (95% CI)	Adjusted Prevalence Ratio (95% CI) ^b
Age Group, in Years			
18-29	40.0 (22.7, 59.4)	Ref	
30-39	42.3 (30.6, 54.6)	1.1 (0.6, 1.8)	
40-49	40.9 (30.5, 51.9)	1.0 (0.6, 1.7)	
50-59	44.0 (32.6, 55.9)	1.1 (0.7, 1.8)	
≥60	27.5 (15.9, 41.7)	0.7 (0.4, 1.3)	
Ethnicity^c			
Palauan	44.8 (38.1, 51.6)	1.6 (1.1, 2.3)	
Other	27.7 (18.9, 37.9)	Ref	
General Health Status^d			
Poor/Not good	66.7 (52.5, 78.9)	2.1 (1.4, 3.3)	
Good/Fair/Okay	34.0 (27.4, 41.1)	1.1 (0.7, 1.7)	
Excellent/Very good	31.4 (19.1, 45.9)	Ref	
Body Mass Index			
≥30	53.1 (43.5, 62.6)	1.7 (1.3, 2.2)	
<30	32.2 (25.8, 39.1)	Ref	
Any Tobacco and/or Betel Nut Use^e			
Any betel nut or tobacco use	50.3 (42.7, 57.8)	2.0 (1.4, 2.7)	1.8 (1.3, 2.5)
Neither	25.7 (18.6, 33.9)	Ref	

^a Of those who 1) responded "Yes" to ever having tried to get pregnant and 2) provided a response to the question "At any time, did you try for more than 12 months and not become pregnant?" (self-reported lifetime episode of infertility). ^b Calculated with a generalized linear model using a log link and assuming a binomial distribution, adjusting for BMI. ^c "Other" consists of Filipino or self-reported "Other" ethnicity. ^d General health status was based on self-report. ^e Any tobacco and/or betel nut use defined as tobacco use only, betel nut use only, or both tobacco and betel nut use.

Discussion

This is the first study to report on the prevalence of and associations with female infertility in the Republic of Palau, which is an under-represented population in the public health literature. Nearly 40% of women who had ever tried to become pregnant self-reported having had an episode of infertility at some point in their lifetime. The estimates of infertility in this population (39.7%) are notably higher than those from the United States (6.7%).³⁰ Lifestyle risk factors, such as tobacco and betel nut use, were also highly prevalent, with more than half of women in Palau regularly using either or both.

Women in Palau using any tobacco and/or betel nut were significantly more likely than non-users to report a lifetime episode of infertility.^{22,31} Estimates of rates of cigarette smoking among women in Palau are lower than those of women in the United States, with estimates of 9.7% and 13.5%, respectively.^{8,32} Prior studies have shown relationships between smoking tobacco and female infertility, with smoking more than half of a pack of cigarettes per day associated with reduced fecundity.^{33,34} More than half (55.1%) of women in Palau reported betel nut chewing in the past 30 days, with or without tobacco.⁸ Although no prior studies have been performed evaluating the association between betel nut use and infertility, previous studies have found betel nut use to be associated with adverse pregnancy outcomes.^{4,20} Prior studies have also found that mothers who chewed tobacco with betel nut had 2.4 times the risk of having a LBW baby at full term compared to non-chewers.²⁰

Women who are obese are at increased risk for reproductive health complications compared to their non-obese counterparts, including higher rates of preterm birth and poorer fertility outcomes following assisted reproductive technology.^{20,35-39} In this population-based study, we found that more than one-third of women in Palau had a BMI defined as obese (≥ 30), similar to prior estimates from the 2013 Palauan National Health Profile and lower than US estimates.^{4,40} In our analysis, obese women had a higher prevalence of self-reported infertility compared to women of all other BMI categories and BMI confounded the association between tobacco and/or betel nut use and infertility. It is possible that BMI also modifies this association (e.g., obese women who use tobacco and/or betel nut may experience higher rates of infertility than normal weight women who use tobacco and/or betel nut). However, given our small sample size, we may not have been able to detect meaningful differences. It is also possible that other health and lifestyle risk factors affecting women's reproductive health, such as nutrition, exercise, stress, caffeine, alcohol use, and environmental exposures, could affect the association between tobacco and/or betel nut use and infertility in this population.⁴¹ Studies with larger sample sizes could help disentangle the potential interactions of these health and lifestyle risk factors and refine interventions to reduce reproductive health complications.

Other factors known to be associated with infertility are STIs. Infection with *Chlamydia trachomatis* (CT) is the leading preventable cause of tubal factor infertility, and is assumed to act via the intermediate development of pelvic inflammatory disease (PID) which subsequently leads to tubal scarring resulting in infertility.^{42,43} PID, and subsequent infertility, can be prevented with prompt detection and treatment of infections, most commonly infections with CT.^{44,45} CT is the most commonly reported infection in the Republic of Palau.⁴ Data from the 2013 National Health Profile in Palau indicate that the CT case rate in 2011 was 1149 cases per 100 000 population, 2.5 times the rate for the general US population that year (453.4 per 100,000 population); 75% of reported cases were among women.^{4,46} Given that 2 out of every 5 women in Palau self-report infertility, the typical association of infertility with a prior chlamydial infection, and the high rates of reported CT in women in Palau, future research should investigate possible associations between a prior chlamydial infection and infertility in this population. Including questions on CT and other STI history, including partner history, and potential sequelae would be useful in future surveys.

There were a number of limitations to this analysis. First, although the survey was population-based, the data were not weighted to account for the stratified sampling design used to recruit survey participants. Point estimates may be subject to non-response bias and may over- or under-represent subpopulations in Palau. Second, the overall sample size was small, particularly when restricted to women who reported having tried to become pregnant. This limited our ability to estimate the prevalence of infertility among sub-populations (eg, young women of other ethnicity). For the same reasons, we were unable to evaluate associations of tobacco and betel nut use separately with infertility. It is also possible that we could not detect important effect measure modifiers, limiting our ability to evaluate the likely complicated association between tobacco and betel nut use and other lifestyle characteristics. The existence of a dose-response effect between tobacco and reduced fecundity has been reported and was of interest in evaluating in this population.³³ However, sample size limitations prevented the analysis of data to that level of granularity. Third, although the survey covered a number of lifestyle questions, some possible important confounders, such as a history of STIs, were not collected. There are a variety of other causes of infertility, including polycystic ovarian syndrome, premature ovarian failure, endometriosis, and autoimmune diseases, such as lupus. These conditions were also not mentioned in the survey and should all be considered valuable areas for future research. Fourth, with the exception of BMI, the variables used in this analysis were based on self-report, including the general health status of the participants, as well as the main outcome of a lifetime episode of infertility, which may have biased our estimates. Questions regarding former vs current tobacco and/or betel nut use were not asked as a part of the survey and would have been an important distinction

to have evaluated. In addition, women reporting an episode of infertility were not asked whether they had a subsequent pregnancy. Finally, the temporality of the presence of health and/or lifestyle factors in relation to a self-reported episode of infertility was not assessed. For example, a woman could report an episode of infertility that occurred when she was 20 years old and was using tobacco, but responded to the survey when she was 40 years old and did not use tobacco, resulting in a misclassification of exposure. In light of these limitations, the results of these analyses should be interpreted as showing that women in Palau who have experienced an episode of infertility during their lifetime are more likely to have used tobacco and/or betel nut during their lifetime and have a higher BMI.

Based on a population-based survey, we document a high prevalence of self-reported infertility among women in Palau and illustrate a complex web of interrelated health and lifestyle factors, including tobacco and betel nut use, which may affect the reproductive health of women in the Republic of Palau. Since betel nut chewing is a cultural norm in Palau and the prevalence of tobacco use, obesity, and poor general health are all high, it is important to understand how these factors may be leading to a serious public health issue and to identify the most effective ways to intervene. Similarly, a better understanding of the role of a variety of health problems as causes of infertility in Palau is important. The high prevalence of and associations between health and lifestyle factors with infertility identified in this study may also be informative for other Pacific island nations that have customs similar to those of Palau. The results of this study highlight the need for more research to understand the infertility experiences of women in Palau and to promote healthy lifestyle factors contributing to optimal reproductive health in the Pacific island nations.

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Conflicts of Interest

The authors report no conflicts of interest.

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Highly-Effective Contraception Use More Likely Among Native Hawaiian Women than Non-Native Hawaiian Women at Title X Clinics in Hawai'i

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Abstract

Differences in contraceptive method use have been noted among women of different races, but studies describing contraceptive method use among Native Hawaiian women have not been published. To examine method choice in this group, the authors conducted a database review of the Hawai'i State Department of Health Title X program. Reviewed were client visit records (CVRs) that health care providers completed for women who were ages 15-44 years, avoiding pregnancy, not currently pregnant, and using a contraceptive method (N=54513). Because a patient could have had several visits during the study period, the contraceptive method chosen at the last visit was selected for analysis. Statistical analyses included descriptive statistics, bivariate analyses, and logistic regression. The proportion of Native Hawaiian women who selected a highly-effective method of contraception (HEC), defined as an intrauterine device, implant, or permanent contraception, was higher than the proportion of non-Native Hawaiian women who selected an HEC. Overall, 15.4% of Native Hawaiian women during the study period chose HEC, compared to 8.8% of non-Native Hawaiian women. In a logistic regression analysis, Native Hawaiian women ages 15-29 were 1.46 times more likely to use HEC (95% CI: 1.35-1.58) than non-Native Hawaiian women ages 15-29, and Native Hawaiian women ages 30-44 were 1.69 times more likely to use HEC (95% CI: 1.53-1.87) than non-Native Hawaiian women in the same age group. Because Native Hawaiian women are reported to have higher rates of unintended pregnancy in the state compared to other racial groups, additional research exploring contraceptive non-use and pregnancy intention are needed.

Keywords

Native Hawaiian, contraception, Title X, unintended pregnancy, IUD, implant, permanent contraception

Abbreviations

CVR = Client visit record
FPL = federal poverty line
HEC = highly effective method of contraception
IUD = intrauterine device
PRAMS = Pregnancy Risk Assessment Monitoring System
RUCA = Rural-Urban Commuting Area

Introduction

A commonly used definition of an unintended pregnancy is a pregnancy that is either mistimed (ie, a woman did not want to become pregnant at the time the pregnancy occurred, but did want to become pregnant at some point in the future) or unwanted (ie, a woman did not want to become pregnant then or at any time in the future).¹ Compared to other developed

countries, the United States has a high rate of unintended pregnancy.² Unintended pregnancy is a significant health problem in Hawai'i, which ranked second in the nation for unintended pregnancy in 2010, with a rate of 61 unintended pregnancies per 1000 women.³ Public health endeavors have focused on addressing unintended pregnancies because of their association with adverse health outcomes for both mothers and children.¹ The data suggest Native Hawaiians are disproportionately affected by unintended pregnancy. According to data from the Hawai'i Pregnancy Risk Assessment Monitoring System (PRAMS), a survey obtained from postpartum women, among Native Hawaiian women who had a live birth between 2007-2011, 57% of pregnancies were unintended.⁴ This represents the highest proportion of unintended pregnancies among the major racial groups in Hawai'i.

Women experience unintended pregnancy because of a number of factors including contraceptive use and non-use and the inherent effectiveness of various methods. For this study, highly-effective contraception (HEC) was defined as any method with a failure rate of less than 1%.⁵ This group includes permanent sterilization, intrauterine devices (IUDs), and contraceptive implants. HEC has great potential to reduce unintended pregnancy rates in part because after the device is placed or the procedure is performed, HEC requires little effort on the part of the user and yet is highly effective.

This study sought to understand contraceptive use patterns among Native Hawaiian women and to determine whether Native Hawaiian women are more or less likely to choose an HEC than non-Native Hawaiian women in Title X clinics in Hawai'i.

Methods

A database review was conducted of the Hawai'i State Department of Health Title X program and records from 2006 to 2012 were gathered and examined. Enacted in 1970, Title X is a federal grant program dedicated to providing individuals with comprehensive contraceptive services.⁶ Title X family planning clinics provide reproductive health care, including contraceptives, at low or no cost to patients. The Title X program was selected because many barriers to contraception, such as financial and availability barriers, are removed or decreased at

these clinics. The contraceptive method a patient uses is more likely an accurate reflection of the method she preferred rather than a method she chose because of financial, insurance, or access limitations.

The database consisted of information extracted from the Family Planning Client Visit Record (CVR), which is completed by a clinic staff member at the end of every family planning patient visit. The CVR includes the primary contraceptive method selected at the end of the visit, types of services provided at that visit, as well as demographic and socioeconomic information. Data from all women seen during the study period who were between ages 15 and 44, avoiding pregnancy, not currently pregnant, and chose to use a contraceptive method at the end of the visit were included. Because patients could have several visits during the study period, the contraceptive method used at the most recent visit was used. Women who reported not using any method of contraception, including those who stated they were avoiding pregnancy were excluded because the study was done to examine the contraceptive choices made by women who desired a contraceptive method.

In the CVR, a patient can be identified with more than one race. All women who identified as full or part Native Hawaiian were included in the Native Hawaiian group. Women who did not identify as full or part Native Hawaiian were included in the non-Native Hawaiian group.

Statistical analyses included descriptive statistics and chi-square tests for categorical variables. Variables examined in bivariate analysis included: income, insurance, visit year, citizenship, English proficiency, provider type, and Rural-Urban Commuting Area Codes (RUCA) category. Multiple logistic regression assessing the impact of being Native Hawaiian on use of HEC and adjusting for confounders were performed. When age was added to the model, the association between the dependent and independent variables was strengthened. Stratified multivariate regression analyses based on 2 age categories, 15-29 years and 30-44 years, were performed. To broadly evaluate whether the relationship between being Native Hawaiian and use of HEC remained, only 2 age categories were used. Potential confounders were included in the model if they were significantly associated with both being Native Hawaiian and HEC use at $P < .1$ bivariately. SPSS version 24.0 (IBM Corp., Armonk, NY) was used for all analyses. This study was deemed exempt by the University of Hawai'i Committee on Human Studies.

Results

Of 205,036 CVRs, with data from 78,355 unique patients, in the Hawai'i State Department of Health Title X database between 2006 and 2012, 54,513 women/visits met the inclusion criteria. Of the women excluded, 5,444 were excluded because they did not choose a contraceptive method. Similar proportions of Native Hawaiian and non-Native Hawaiian women were excluded from the primary analysis because a contraceptive method was not chosen (10.1% of Native Hawaiian women versus 8.8% of non-Native Hawaiian women). Of the 54,513 women included, more than one-quarter (28.3%) were under 20 years old; more than three-quarters (77.6%) were under 30 years old. Most of the women (79.0%) reported incomes at or below 100% of the federal poverty level (FPL); 46.2% were uninsured. Of the eligible women, 23.4% identified as Native Hawaiian. Native Hawaiian and non-Native Hawaiian women in the sample differed significantly on all demographic characteristics except for provider type (Table 1). Of note, Native Hawaiian women tended to be younger than non-Native Hawaiian women. Users of HEC differed significantly from women who chose other types of contraception on all of the demographic characteristics examined (Table 2).

Between 2006 and 2012, there was an overall increase in the use of HEC among all clients, from 3.2% in 2006 to 14.3% in 2012 (Figure 1). In almost every year, the proportion of Native Hawaiian women using HEC was higher than the proportion of non-Native Hawaiian women using HEC. Overall, 15.4% of Native Hawaiian women during the study period chose HEC, compared to 8.8% of non-Native Hawaiian women. Use of each type of HEC was higher among Native Hawaiian women than non-Native Hawaiian women: IUDs (6.7% versus 4.6%), implants (4.7% versus 2.1%), and sterilization (4.0% versus 2.2%) (data not shown).

A logistic regression to compare HEC use in Native Hawaiian versus non-Native Hawaiian women was performed (Table 3). In the overall adjusted analysis, Native Hawaiian women were 1.37 (95% CI: 1.29-1.46) times more likely to use HEC than non-Native Hawaiian women. After stratifying by age, the association remained significant. Native Hawaiian women ages 15-29 were 1.46 times more likely to use HEC (95% CI: 1.35-1.58) than non-Native Hawaiian women ages 15-29, and Native Hawaiian women ages 30-44 were 1.69 times more likely to use HEC (95% CI: 1.53-1.87) than non-Native Hawaiian women of the same age range.

Table 1. Demographic Characteristics of Native Hawaiian and Non-Native Hawaiian Contraception-using Women Seen at Hawai'i Title X Clinics from 2006-2012

Variable	Native Hawaiian women n=12 763 (23.4%)	Non-Native Hawaiian women n=41 750 (76.6%)	Total N=54 513 (100%)	P-value
Age				
15-17 yo	2594 (20.3%)	5272 (12.6%)	7866 (14.4%)	<.001
18-19 yo	2248 (17.6%)	5292 (12.7%)	7540 (13.8%)	
20-24 yo	3385 (26.5%)	12 496 (29.9%)	15 881 (29.1%)	
25-29 yo	2097 (16.4%)	8929 (21.4%)	11 026 (20.2%)	
30-34 yo	1226 (9.6%)	4808 (11.5%)	6034 (11.1%)	
35-39 yo	660 (5.2%)	2948 (7.1%)	3608 (6.6%)	
40-44 yo	553 (4.3%)	2005 (4.8%)	2558 (4.7%)	
Income Category^{a,b}				
Less than 100% FPL	10 501 (84.2%)	31 654 (77.5%)	42 155 (79.0%)	<.001
101%-200% FPL	1306 (10.5%)	5964 (14.6%)	7270 (13.6%)	
201% FPL and above	663 (5.3%)	3248 (7.9%)	3911 (7.3%)	
Unknown/blank	293	884	1177	
Insurance Category^a				
Uninsured	4116 (32.7%)	20 807 (50.3%)	24 923 (46.2%)	<.001
Public insurance	5583 (43.4%)	10 174 (24.6%)	15 757 (29.2%)	
Private insurance	2839 (22.6%)	10 080 (24.4%)	12 919 (23.9%)	
Military insurance	41 (0.3%)	314 (0.8%)	355 (0.7%)	
Unknown	184	375	559	
Visit Year				
2006	570 (4.5%)	2528 (6.1%)	3098 (5.7%)	<.001
2007	1144 (9.0%)	4663 (11.2%)	5807 (10.7%)	
2008	1500 (11.8%)	5651 (13.5%)	7151 (13.1%)	
2009	1903 (14.9%)	6386 (15.3%)	8289 (15.2%)	
2010	2186 (17.1%)	7226 (17.3%)	9412 (17.3%)	
2011	3045 (23.9%)	8721 (20.9%)	11 766 (21.6%)	
2012	2415 (18.9%)	6575 (15.7%)	8990 (16.5%)	
US Citizen				
Yes	12 762 (100.0%)	39 184 (93.9%)	51 946 (95.3%)	<.001
No	1 (0.0%)	2566 (6.1%)	2567 (4.7%)	
Limited English Proficiency				
Yes	58 (0.5%)	1374 (3.3%)	1432 (2.6%)	<.001
No	12 704 (99.5%)	40 376 (96.7%)	53 080 (97.4%)	
Provider Type				
MD	2593 (20.3%)	8419 (20.2%)	11 012 (20.2%)	.681
NP, CNM, PA	9640 (75.5%)	31 659 (75.8%)	41 299 (75.8%)	
RN/LPN, other	529 (4.1%)	1668 (4.0%)	2197 (4.0%)	
RUCA Category^{a, c}				
Urban core	5476 (43.1%)	20 255 (49.6%)	25 731 (48.1%)	<.001
Suburban	1228 (9.7%)	2678 (6.6%)	3906 (7.3%)	
Large rural town	4252 (33.5%)	14 883 (36.5%)	19 135 (35.7%)	
Small rural town	1744 (13.7%)	3012 (7.4%)	4756 (8.9%)	
Missing	63	922	985	

^a Percentages represent valid percentages, excluding missing/unknown values; ^b Federal Poverty Level; ^c Rural-Urban Commuting Area Codes

Table 2. Demographic Characteristics of Contraception-using Women Seen at Hawai'i Title X Clinics from 2006-2012 by Method Effectiveness

Variable	Highly Effective Contraception Users n=5640 (10.3%)	Other Contraception Users n=48 873 (89.7%)	P-value
Race			
Native Hawaiian	1969 (34.9%)	10 794 (22.1%)	<.001
Non-Native Hawaiian	3671 (65.1%)	38 079 (77.9%)	
Age			
15-17 yo	264 (4.7%)	7602 (15.6%)	<.001
18-19 yo	347 (6.2%)	7193 (14.7%)	
20-24 yo	1107 (19.6%)	14 774 (30.2%)	
25-29 yo	1299 (23.0%)	9727 (19.9%)	
30-34 yo	1064 (18.9%)	4970 (10.2%)	
35-39 yo	847 (15.0%)	2761 (5.6%)	
40-44 yo	712 (12.6%)	1846 (3.8%)	
Income Category^{a,b}			
Less than 100% FPL	4456 (80.1%)	37 699 (78.9%)	<.001
101%-200% FPL	707 (12.7%)	6563 (13.7%)	
201% FPL and above	401 (7.2%)	3510 (7.3%)	
Unknown/blank	76	1101	
Insurance Category^a			
Uninsured	1090 (19.6%)	23 833 (49.3%)	<.001
Public insurance	3346 (60.0%)	12 411 (25.7%)	
Private insurance	1111 (19.9%)	11 808 (24.4%)	
Military insurance	27 (0.5%)	328 (0.7%)	
Unknown	66	493	
Visit Year			
2006	100 (1.8%)	2998 (6.1%)	<.001
2007	230 (4.1%)	5577 (11.4%)	
2008	444 (7.9%)	6707 (13.7%)	
2009	671 (11.9%)	7618 (15.6%)	
2010	1070 (19.0%)	8342 (17.1%)	
2011	1836 (32.6%)	9930 (20.3%)	
2012	1289 (22.9%)	7701 (15.8%)	
US Citizen			
Yes	5229 (92.7%)	46 717 (95.6%)	<.001
No	411 (7.3%)	2156 (4.4%)	
Limited English Proficiency			
Yes	321 (5.7%)	1111 (2.3%)	<.001
No	5318 (94.3%)	47 762 (97.7%)	
Provider Type			
MD	1461 (25.9%)	9551 (19.5%)	<.001
Advanced Practice Clinicians	4063 (72.0%)	37 236 (76.2%)	
Nurse, other	116 (2.3%)	2081 (4.3%)	
RUCA Category^{a,c}			
Urban core	3429 (61.1%)	22 302 (46.5%)	<.001
Suburban	254 (4.5%)	3652 (7.6%)	
Large rural town	1203 (21.4%)	17 932 (37.4%)	
Small rural town	726 (12.9%)	4030 (8.4%)	
Missing	28	957	

^a Percentages represent valid percentages, excluding missing/unknown values; ^b Federal Poverty Level; ^c Rural-Urban Commuting Area Codes

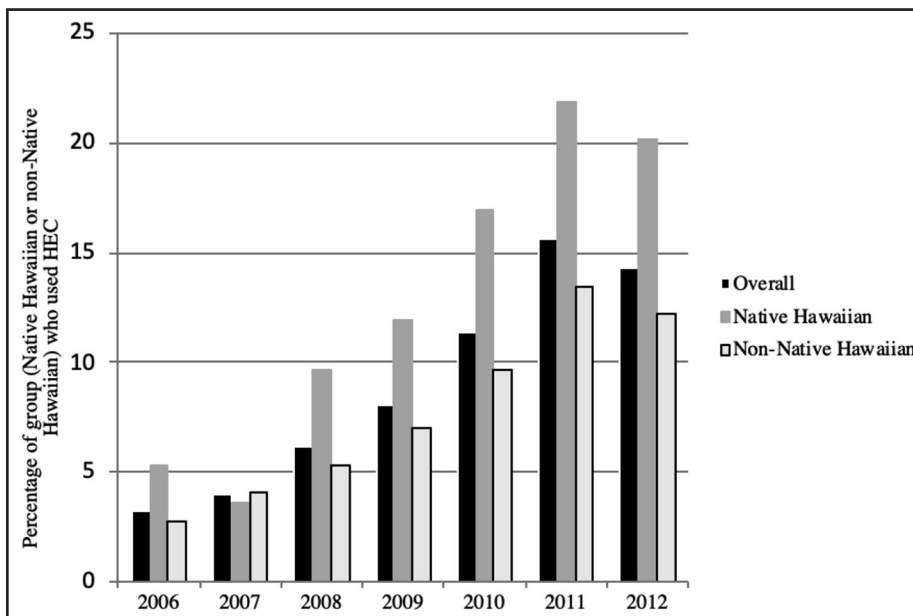


Figure 1. Use of Highly Effective Contraception Between 2006-2012 by Native Hawaiian and Non-Native Hawaiian Women Who Chose a Contraceptive Method at a Title X Clinic in Hawai'i

Table 3. Among Women at Title X Clinics in Hawai'i Who Chose a Contraceptive Method, the Likelihood of Native Hawaiian Women Using HEC Relative to Non-Native Hawaiian Women (Non-Native Hawaiian as Reference 1.0)

	Unadjusted Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)
Overall (Ages 15-44)^a		
Native Hawaiian	1.89 (1.78-2.01)	1.37 (1.29-1.46)
Non-Native Hawaiian	ref	ref
Ages 15-29^b		
Native Hawaiian	2.06 (1.91-2.23)	1.46 (1.35-1.58)
Non-Native Hawaiian	ref	ref
Ages 30-44^b		
Native Hawaiian	2.16 (1.96-2.38)	1.69 (1.53-1.87)
Non-Native Hawaiian	ref	ref

^a Adjusted for visit year and insurance type

^b Adjusted for insurance type

Discussion

In this analysis of Title X data, Native Hawaiian women who visited Title X clinics in Hawai‘i were more likely to use highly-effective methods of contraception (HEC) than non-Native Hawaiian women. There was an increase in use of HEC from 2006-2012, which is consistent with national studies of contraceptive use.^{7,8} IUD and implant use nearly doubled from 3.8% (2006-2010) to 7.2% (2011-2013) among U.S. women ages 15-44.⁹ A recent study specifically explored IUD and implant use among adolescents at Title X sites nationally.¹⁰ Among teens ages 15-19 seeking contraceptive services at these sites, use of IUDs and implants increased from 0.4% in 2005 to 7.1% in 2013, a more than 15-fold increase.¹⁰ Hawai‘i ranked 5th highest in Title X teen client IUD and implant use, at 14.4%.⁹ While HEC use in this study increased among both Native Hawaiian and non-Native Hawaiian women between 2006-2012, the proportion of Native Hawaiian women using HEC was greater than that of non-Native Hawaiian women nearly every year.

This study is consistent with other findings demonstrating that differences in method choice exist by race. However, contrary to our results, several other studies have shown that racial minority women are less likely to use highly effective methods such as IUDs and implants.^{8,11,12} Various factors have been suggested as a cause for these differences, such as limitations to access, lack of education, mistrust based on historical reproductive injustice, and bias by medical professionals.^{8,11,12,13} As Native Hawaiians also experience numerous health and health-related disparities, the observed higher rate of HEC use among Native Hawaiian women was unexpected.

Although understanding the factors that influence contraceptive method use is integral to reducing unintended pregnancies, these factors are also part of a broader approach. It has been shown that higher HEC use is associated with lower unintended pregnancy rates and lower abortion rates.¹⁴ This study’s finding that among women choosing contraception, Native Hawaiian women were more likely to use highly effective methods compared to non-Native Hawaiian women. This implies that other factors—besides choice of contraceptive method—may influence the higher rates of unintended pregnancy among Native Hawaiians. In addition, individuals and communities think about pregnancy and pregnancy intention differently; although the medical literature measures unintended pregnancy as a binary outcome, it is more nuanced.^{8,11,12} Qualitative interviews with Native Hawaiians have captured varied understandings and experiences with “unintended pregnancies,” including pregnancy ambivalence and limited agency to plan pregnancies (ie, “pregnancy just happens”),¹⁵ indicating that current measurement of this concept is insufficient and perhaps less relevant as a health indicator in this community. Furthermore, Native Hawaiian women were more likely than non-Native

Hawaiian women to use no contraceptive method, and women who were not using any contraception were excluded from the current analysis. If Native Hawaiian women with ambivalent pregnancy intentions were more likely than ambivalent non-Native Hawaiian women to forego contraception altogether, this may have artificially inflated the proportion of Native Hawaiian women using HEC when looking only at women using contraception, as in this analysis. Further research is necessary to explore contraceptive method choice and pregnancy intentions among diverse populations.

Other limitations of this study include the reliance of the CVR forms on the self-identification of race and ethnicity, and the categorization of women into 2 racial categories (Native Hawaiian and non-Native Hawaiian) to specifically explore contraceptive use among Native Hawaiian women. Combining all other races could mask other differences in contraceptive use that may exist for other demographic groups. Pertinent variables, such as parity and clinic-specific information, were not available. Counseling and methods available may vary depending on the site visited and potentially influence the contraceptive method selected. The analysis was based at family planning clinics in Hawai‘i and may not be generalizable to other settings.

Strengths of this study include use of a large database compiled by clinics across the state. Although Native Hawaiian women are included in national studies, they are often grouped with Asian or Other Pacific Islander women. The Hawai‘i Title X database is one of the few sources of data where they can be examined as a separate group. This study is the only known published data on contraceptive method use among Native Hawaiians.

Unintended pregnancy is a public health problem that affects women and children. Native Hawaiians appear to have the highest rates of unintended pregnancy in Hawai‘i. It is integral to examine contraceptive use as a part of a broader approach in any effort to reduce unintended pregnancy. The fact that Native Hawaiian women are more likely to use the most effective methods of contraception than non-Native Hawaiian women indicates that other factors, such as health care delivery or our insufficient definitions around unintended pregnancy, should be examined to understand and better address unintended pregnancy among Native Hawaiian women.

Conflict of Interest

None of the authors identify a conflict of interest.

Disclosure Statement

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THE DANIEL K. INOUE COLLEGE OF PHARMACY SCRIPTS

A Collaborative Community-Based Sun Protection Education Program

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Abbreviations

DKICP = Daniel K. Inouye College of Pharmacy
KAB = knowledge, attitudes, and behaviors
SPF = sun protection factor
UHCC = University of Hawai'i Cancer Center
UPF = ultraviolet protection factor
UV = ultraviolet
UVA = ultraviolet A radiation
UVB = ultraviolet B radiation
UVR = ultraviolet radiation

Introduction

In the United States (U.S.), skin cancer has become the most commonly diagnosed cancer. It affects nearly 5 million people at an estimated annual cost of approximately \$8.1 billion.¹ The annual number of new U.S. cases of melanoma of the skin increased from 40,791 in 1999 to 82,476 in 2016. This trend reflects increases in new melanoma of the skin cases reported in Hawai'i which rose from 180 in 1999 to 447 in 2016.² The Surgeon General's 2014 Report was a call to action for the prevention of skin cancer.¹

Most ultraviolet (UV) exposure comes from UVA rays that penetrate deep into the dermis and cause unseen skin cell damage. While most UVB rays are filtered by the ozone layer in the atmosphere, they affect the superficial layers of the skin, causing sunburn and cellular DNA damage.³⁻⁴ The UV index expresses sun exposure risk using a scale of 0-15, where higher numbers indicate greater overexposure risk.³ Hawai'i's UV index during the winter months has been reported to average 6 (High) and during the summer averages 11-12 (Extreme). By comparison, Miami, Florida has an average winter UV index of 4 (Moderate) and that of Portland, Oregon 1 (Low).⁵ Many individuals in Hawai'i, including Asian Americans, Native Hawaiians, Filipinos, other Pacific Islanders, and multiethnic individuals, may have skin which is moderately to markedly pigmented. While skin cancers are less common in people with darker complexions, inaccurate skin cancer risk perceptions in non-whites may

contribute to prolonged ultraviolet radiation (UVR) exposures, increased sunburn prevalence, delayed skin cancer diagnosis, and greater risks for death in comparison to Caucasian individuals.⁶⁻⁹

Pickleball is a rapidly growing sport in the U.S. with approximately 2.5 million active players. This sport is a cross between tennis, ping pong, and badminton, and is traditionally played outdoors.¹⁰ Skin cancer risk perceptions addressing pickleball have not been previously reported. In this project, skin protection knowledge, attitudes, and behavioral propensities (KABs) were assessed through an adapted sun protection survey. In addition, information regarding age, ethnicity, and gender as cofactors regarding sun protection KABs were gathered. This study intended to build awareness, perceived susceptibility, and a better understanding of risk-to-appearance as important motivational factors towards modifying sun protection behaviors in an often multiethnic population in Hawai'i. This project is particularly important to our local pickleball community because Hawai'i has a high UV index throughout the year.

Methods

Study participants were recruited at open play outdoor pickleball sessions in Honolulu during the summer of 2018. Pickleball players were welcome to participate. Pickleball sessions were chosen because players often spend significant time in the sun which increases their risks for UVR skin damage.

This educational project was a collaborative effort between the Daniel K. Inouye College of Pharmacy (DKICP), the University of Hawai'i Cancer Center (UHCC), the O'ahu Pickleball Association, and the Hawai'i Skin Cancer Coalition. The project development team included two faculty members from the DKICP, fourth-year pharmacy students, and an Assistant Professor at the University of Hawai'i Cancer Center. The team developed the study protocol, survey instrument, and educational materials. The survey items were adapted from a previously validated survey tool and a modified survey for a multiethnic population in Hawai'i.^{8,11} (Table 1)

Table 1. Sun Protection Survey Questions	
Content	Response Set
1. To work best, sunscreen needs a half hour to be absorbed by the skin.	True/False (True)
2. You don't need to worry about skin cancer if you only go out for short periods of time (10 to 20 minutes).	True/False (False)
3. A sun protection factor (SPF) rating of 15 or greater means you can stay outside for 3 hours without getting a burn.	True/False (False)
4. People with light hair and light skin have the greatest risk of getting skin cancer.	True/False (True)
5. Sunburn is painful, but not really harmful in the long run.	True/False (False)
6. People who only go out in the sun for two weeks a year are not likely to get skin cancer.	True/False (False)
7. Being in water provides natural sun protection.	True/False (False)
8. Sun exposure during childhood can increase a person's chance of getting skin cancer later in life.	True/False (True)
9. People are more attractive if they have a tan.	Strongly disagree...strongly agree (5-point scale)
10. It's too much bother to put on a hat when I go outside.	Strongly disagree...strongly agree (5-point scale)
11. I find it difficult to protect myself from the sun.	Strongly disagree...strongly agree (5-point scale)
12. I am confident with properly selecting a sun screen/sun protection product and using it correctly.	Strongly disagree...strongly agree (5-point scale)
13. It helps to wear a shirt with sleeves.	Not at all...a great deal (4-point scale)
14. It helps to have a good base suntan.	Not at all...a great deal (4-point scale)
15. It helps to stay in the shade or under an umbrella	Not at all...a great deal (4-point scale)
16. It helps to use sunscreen.	Not at all...a great deal (4-point scale)
17. It helps to wear a hat.	Not at all...a great deal (4-point scale)
18. It helps to limit the number of hours outdoors when the sun's rays are strongest, at mid-day.	Not at all...a great deal (4-point scale)
19. It helps to wear sunglasses.	Not at all...a great deal (4-point scale)

Note: The correct answer for the true/false questions is in parentheses.

The DKICP team and an UHCC undergraduate intern attended four pickleball sessions at three venues in Honolulu to conduct sun projection education. Standardized orientation and training were provided for all study team members in using the educational materials and tools utilized. After consenting to participate, participants completed a survey regarding sun protection practices. In addition, fourth-year student pharmacists delivered a 10-minute educational session on sun protection. Using visuals printed in a large flip chart format (18" X 24"), the student pharmacists covered an array of topics related to sun projection including:

Table 2. Education Session Topics
Skin cancer prevalence in Hawai'i compared to the nation
What to look for in skin cancer (photos with types of skin cancer)
Facts about skin cancer
Difference between SPF and UPF
Sun Protective alternatives
Mineral versus chemical sunscreens
UVA versus UVB rays
How to protect your skin
Hawai'i law that limited sale of sunscreens with certain chemicals ¹²
Review of studies of banned chemicals
Conflicting opinions regarding the ban
Acknowledgements of funding

Following the educational presentation, participants explored sun damage using tools provided by the UH Cancer Center: APRIL[®] and UV exposure assessment. APRIL[®], manufactured by AprilAge Inc., was used to illustrate the long-term effects of UV exposures in multiethnic participants.^{13,14} APRIL[®] face aging software product provided a personal “before and after” view of an individual’s own face as they age, decade by decade. The APRIL[®] “aging engine” extracts specific aging characteristics from a database of several thousands of 3D head scans from real people across five ethnic groups including male/female from ages 7 to 70. It is currently used in more than 25 countries in health education, science museums, employee health programs, and brand marketing for cosmetics and beauty. The software demonstrates to participants how they will look as they get older due to the effects of heavy sun exposure. Results are produced in a “contrast and compare” output that can be shared, emailed, or printed.

Advanced photography methods of UV and polarized light photographs were used for assessing participants’ current levels of sun damage. UV and polarized light photography displays the immediate effects of overexposure to UVR in multiethnic populations as visible irregularities in the skin’s complexion.¹⁵ The goal was to present multiethnic participants with the immediate and long-term effects of UVR exposures. The digital photos used for APRIL[®] and UV damage assessment were deleted from all digital sources after viewing by the participant. Personal information was omitted from the participant’s picture.

By calculating the percentage of respondents providing each response, this descriptive project summarizes the participants' sun protection survey results. Because of minimal risk, this project was deemed exempt by the University of Hawai'i Institutional Review Board. All analyses were conducted in Stata V10 (College Station, TX).

Results

Forty-three participants were recruited. The mean age of the participants was 58.9 years (SD 9.3 years), with a range of 41 to 83 years. Females (n=29) comprised 67.4% of respondents, males (n=13) 30.2% of respondents. One respondent did not report sex. In terms of self-reported race/ethnicity, 20.9% of the study population were white, 27.9% Japanese, 27.9% Chinese, 4.7% Native Hawaiian, 2.3% Other Pacific Islanders, and 16.3% were other race/ethnicity (Table 3).

Eight survey questions assessed sun protection knowledge (Figure 1). Ninety-three percent of respondents correctly said the statement that childhood sun exposures increase risk of cancer was true. Similarly, over 83% correctly said that having lighter skin or hair increased risk and over 76% correctly said that sunscreen needs to be absorbed for at least half an hour. Approximately 11% incorrectly said that being out in the sun for only 2 weeks per year reduces risk, and about 9% incorrectly reported that an individual could go out for 3 hours with and SPF 15 sunscreen and not get burnt. Respondents were correct in stating that the following statements were false: (1) water provides sun protection (96%); (2) you do not need to worry about cancer if you're only out for a short time (98%); (3) sunburn is painful but not harmful (98%).

Characteristic	
Age	58.9, SD(9.3) range[41-83]
Female	67.4%
Ethnicity	
White	20.9%
Japanese	27.9%
Chinese	27.9%
Native Hawaiian	4.7%
Other Pacific Islander	2.3%
Other	16.3%

The level of agreement with four sun protection attitude statements varied (Table 4). The strongest agreement came in response to the statement of being confident of sun protection methods with over 74% either responding that they agree or strongly agree. Twenty-eight percent of respondents said they agreed that having a tan was attractive, while approximately 23% said that it was difficult to protect themselves from the sun. In contrast, over 75% of respondents said that they strongly disagreed with the statement that it is too much of a bother to wear a hat.

Finally, seven questions asked whether certain behaviors helped avoid skin cancer (Table 5). Approximately 79% of respondents said that wearing a hat and using sunscreen helped a great deal to protect, while 76% said limiting midday hours outdoors helped a great deal. Approximately 70% said wearing a hat helped to protect, while 63% said wearing a shirt with sleeves helped, and 60% said that staying in the shade helped a great deal. In contrast, only 20% said having a good base tan helped.

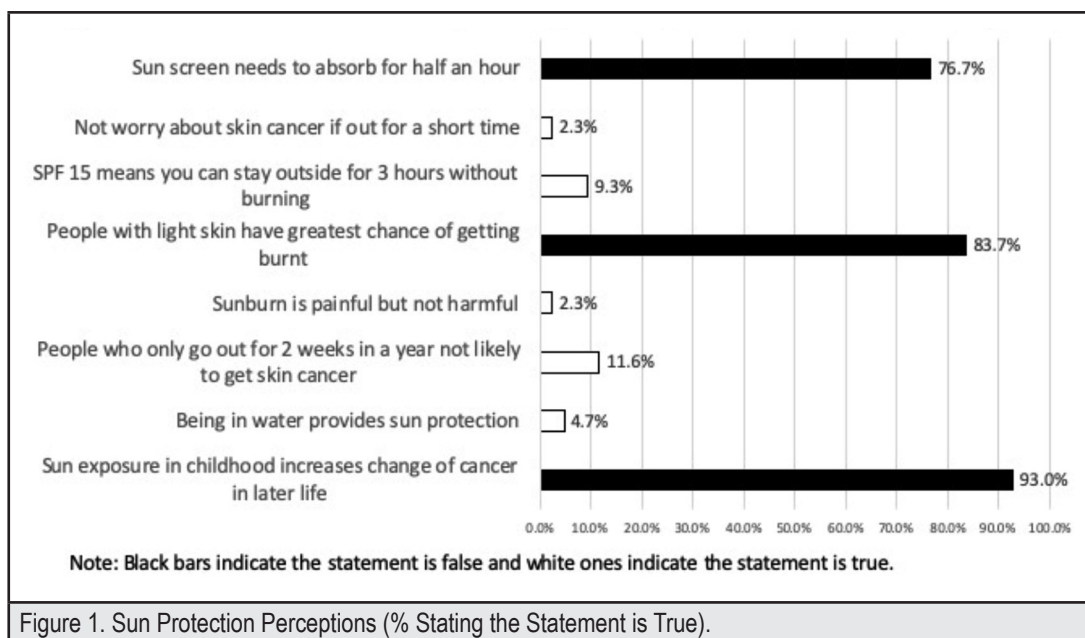


Figure 1. Sun Protection Perceptions (% Stating the Statement is True).

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
Confident in selecting sun screen	0%	12%	14%	53%	21%
Difficult to protect myself from sun	23%	47%	7%	23%	0%
Too much of a bother to put a hat on	33%	42%	9%	14%	2%
People are more attractive with a tan	12%	14%	47%	28%	0%

Statement	Not at all	A little	Somewhat	A great deal
Wear sunglasses	4.7%	2.3%	14.0%	79.1%
Limit hours outdoors at midday	2.3%	2.3%	18.6%	76.7%
Wear a hat	0%	11.6%	18.6%	69.8%
Use sunscreen	2.3%	2.3%	16.3%	79.0%
Good base suntan	25.6%	25.9%	27.9%	20.9%
Wear a shirt with sleeves	4.7%	2.3%	30.2%	62.8%

Discussion

The study population possessed a general understanding of skin cancer risk related to childhood exposure, influence of skin complexion, and sunscreen application timing. The participants also recognized that sun protection garments including hats and long-sleeve shirts could reduce sun exposure. While 74% of the participants agree or strongly agree with their confidence in selecting sun protection methods, 28% believed a tan to be attractive and nearly 21% felt having a good base tan helped. A systematic review described the contribution of appearance-based interventions in promoting positive sun protection behaviors and included photoaging and UV photography interventions.¹⁶

In Hawai‘i, multiethnic individuals, whose skin tans or is moderately to markedly pigmented, can underestimate their cancer risk. As described by the UHCC report, melanoma has been reported to be the fourth most common type of cancer in men and seventh most common in women in Hawai‘i from 2009-2013. Caucasians and Native Hawaiians are the first and second highest ethnic groups to experience this type of cancer, respectively. The age-adjusted melanoma incidence rate (per 100,000) in white males was 84.5 with a mortality rate of 6.1. For Native Hawaiian males, the age-adjusted melanoma incidence rate was 6.7 with a mortality rate of 3, which reflects a worse incidence to mortality ratio for the Native Hawaiian males.¹⁷ Previous studies identified racial disparities in non-white populations who experience lower melanoma survival rates and presented with more advanced disease as compared to white populations.^{18,19}

Other studies targeting outdoor recreation groups including recreational cyclists, snow sports, runners, and surfers have assessed

various aspects of sun protection and cancer prevention.²⁰⁻²³ The study by Petty et al involved a younger study population (mean age of 48 years) which were made up of predominantly male participants (75.1%). Evaluated were components of sun screen use such as costs, rewards, self-efficacy, and photoaging.²⁰ In this study, only 6% of cyclists responded as wanting a tan. In comparison, our study had a mean age of 58.9 years, a majority of female participants (67.4%), and demonstrated a 28% response rate regarding perceiving a tan to be attractive. This response may be influenced by the possibility that those with nonwhite complexions may not see their normal tanned skin tone as unattractive. This was reported in a previous Hawai‘i-based multiethnic study of youths.⁸

In July 2018, Hawai‘i approved a ban of two widely used chemical sunscreen ingredients, oxybenzone and octinoxate. This was the first law passed in the U.S. to prohibit these compounds in sunscreens supporting marine ecosystem preservation. The law becomes effective January 1, 2021.¹² Following this new law, Key West, Florida approved legislation banning the sunscreen chemicals oxybenzone and octinoxate. The nation of Palau has also banned ten sunscreen chemicals.²⁴

It will be important to educate consumers on the risks of sun exposure and address issues that may lead to confusion and reduced sunscreen utilization. During our study, numerous questions regarding the banned sunscreen components came to the attention of the local media. Additionally, a recent JAMA publication that identified systemic absorption of oxybenzone in humans may potentially contribute to hesitancy with sunscreen use.²⁵ Newer broad-spectrum sunscreen agents have already been used in other counties and may provide additional options for those agents legislatively banned in 2021.²⁶

We were fortunate to have the support of the O'ahu Pickleball Association who were enthusiastic about sun safety. Ally, et al, described their experience with educational efforts to promote sun-protective behavior changes in NCAA athletes.²⁷ Their study found that the impact of positive reinforcement by coaching staff should not be underestimated.

Limitations with this study include the sample of participants recruited within urban Honolulu. This may overlook differences in survey responses from samples representing rural participants. Second, this study sample was of limited size. Finally, a post-intervention assessment was not included. An observation noted with UV photography was the relatively frequent participant finding of incomplete sunscreen application. Additional aspects of sunscreen application patterns have previously identified the applied sunscreen quantity being less than optimal to achieve the labeled SPF rating.²⁸ Further research is needed to determine the subsequent effects of the ban on sunscreen use and skin cancer risks.

Pharmacists and health care professionals have a key role in championing sun protection education. Addressing unique community concerns may help to remove barriers to effective sun protection practices. Pharmacists have an important opportunity to create greater clarity for consumers from the myriad of sun protection products available in retail settings. Elaborating on key topics such as broad-spectrum designation, water-resistance, SFP ratings, and common practices leading to improper application can promote informed consumer sunscreen product selection and use. There is also an ongoing need to understand the populations who may be at high risk from the impact of excessive sun exposure to help prevent disproportionately worse health outcomes.

In conclusion, our study identified sun protection KABs of pickleball players within Honolulu. Future research could address education regarding the perception of sun tanning and its ability to confer protection, validation of participant confidence in sun protection application methods, explore barriers to utilizing sun protection modalities, and appearance-based interventions. Additional activities could further engage leaders and coaches within the pickleball community to establish consistent sun protection messaging.

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SOCIAL WORK IN ACTION

How the Hawai'i CARES Program Aims to Strengthen Addiction Treatment Through a Social Work Lens

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Social Work in Action is a solicited column from the social work community in Hawai'i. It is edited by HJMPH Contributing Editor Sophia Kim PhD, of the Myron B. Thompson School of Social Work at the University of Hawai'i at Manoa.

Introduction

Substance use disorders (SUDs) are a major issue both nationally and in Hawai'i. The United States is in the midst of an opioid crisis that claims the lives of approximately 192 people a day.¹ The opioid epidemic alone is estimated to carry an economic burden of up to \$78.5 billion a year.² While SUDs affect people of all walks of life, these disorders have strong health and social impacts on vulnerable populations such as people with mental health disorders and people experiencing homelessness.

According to the Substance Abuse and Mental Health Services Administration (SAMHSA), in 2018, about 7.4% of Americans ages 12 years or older had some form of SUD, equating to 20.3 million individuals. Of those, 18.9 million did not receive any type of specialty addiction treatment.³

In the State of Hawai'i, substance use begins at a younger age as compared with the rest of the nation. Currently, the Hawai'i State Department of Health (DOH) Alcohol and Drug Abuse Division (ADAD) funds addiction treatment. Among those receiving addiction treatment through the State, 11.8% of substance use cases begin before age 12, and 53.8% begin between ages 12-17. The top substances of abuse in the state are methamphetamine (with 34.2% of people with a SUD reporting methamphetamine use), marijuana (30.2%), and alcohol (18.9%). Overall, 44.6% identify as Native Hawaiian, 15.9% as white, 11% as Pacific Islander, and 8.9% as Filipino.⁴

Many people in Hawai'i are in need of treatment, yet do not receive it. From 2010-2012, 92.7% of people in need of alcohol use disorder treatment did not receive it. Similarly, 98% of those in need of substance use disorder treatment did not receive it.⁵

In an effort to make access to addiction treatment more readily available, the DOH and the Myron B. Thompson School of Social Work (MBTSSW) at the University of Hawai'i at Manoa have come together to implement a statewide coordinated en-

try system for connecting clients to local addiction treatment providers. This new program, which began as a pilot program in October 2019, is called the Hawai'i Coordinated Access Resource Entry System, or Hawai'i CARES.

Hawai'i CARES' Primary Functions

The vision of Hawai'i CARES is to provide a continuum of care in which an array of addiction treatment and recovery support services are delivered on-demand to those who need them, when and where they need them. An ideal continuum of care is well coordinated, clinically appropriate, and inclusive of clients in decision making processes.⁶ Hawai'i CARES aims to bring together a statewide network of addiction treatment providers who offer a variety of services across various levels of care. Through the use of various assessment tools, the team is able to determine the appropriate level of care and place the client accordingly.⁷

Hawai'i CARES performs three primary functions. The first is the operation of a call and referral center. The center is staffed by a trained clinical team and responds to calls from clients, SUD treatment providers, the community, and stakeholders. Through the use of a universal screening and intake process, staff facilitate rapid entry into the system of care and ensure service placement based on clinical assessment. In instances where a client's treatment may require changes in levels of care, transitions from one agency to another, or even instances of relapse, staff can continue to follow up with clients and treatment teams to ensure transitions in care are seamless or to potentially re-engage clients in services. Additionally, call center staff are available to answer questions from community members and healthcare professionals to make sure all stakeholders understand how the program works and are comfortable using it. During the pilot phase, the call and referral center functions during typical business hours, but upon full implementation, the Hawai'i CARES call center will function 24 hours a day, seven days a week.

Second, Hawai‘i CARES is the managing entity for addiction treatment services, meaning that it provides clients and service providers with authorizations for ADAD-funded addiction treatment services. This utilization management role is intended to ensure the medical necessity of services provided to clients through clinical reviews of client entry into treatment, transitions in levels of care, and benefits exceptions utilizing the American Society of Addiction Medicine (ASAM) criteria for outcomes-oriented patient care. Management of service authorization requests, including receiving necessary clinical documentation from addiction treatment providers, is done through the state’s electronic medical record system for addiction treatment services, known as the Web Infrastructure for Treatment Services (WITS). The purpose of this process is to facilitate rapid access to clinically appropriate treatment services for those in need.

Third, the program is a mechanism for continuous service and systems quality improvement. Through this, Hawai‘i CARES can improve service accessibility and quality of care, identify shortages in service availability, and coordinate waitlists for inpatient residential beds and other services. This program component helps the process to be responsive to the unique needs of those impacted by alcohol and other substance problems in Hawai‘i while ensuring that the service provided remains useful and robust.

Planning and Implementation

Why Social Work?

The social work profession is well-equipped to take the lead in this new system. Social workers are at the vanguard of efforts to address the health, behavioral health, and social service needs of vulnerable populations. At its foundation, the profession embraces the values of service, competency, social justice, and promoting the dignity and worth of the individual.⁸ Also, through the use of the person-in-environment approach, social workers consider the individual, family, and community context when providing care. This approach is paramount when taking into account the multitude of systems with which substance use disorders intersect.

The MBTSSW is the largest school of social work in Hawai‘i and offers Baccalaureate in Social Work (BSW), Masters in Social Work (MSW), and doctoral (PhD) programs. The school has the resources and ability to educate and train the next generation of behavioral health workers in the state. The school also has access to experts in evaluation and research, who will work to determine the efficacy of the Hawai‘i CARES program and evaluate program and client outcomes. From there, the MBTSSW along with Hawai‘i CARES will work toward adapting to data trends and providing the best, most efficacious, and evidenced-based continuum of care.

Timeline

Early planning for Hawai‘i CARES started well before the MBTSSW became involved in planning and implementing the program. Prior to this, ADAD was studying evidence-based systems reform efforts in other states across the country to identify elements to consider for utilization in its own systems change efforts. This resulted in an updated ADAD Request for Proposal, which was released to the public in late 2018, calling for an improvement to the state’s continuum of care through the planning and implementation of Hawai‘i’s CARES program. The MBTSSW was selected as the state’s contracted entity to plan and implement Hawai‘i CARES in early 2019, and planning began in the summer of 2019. A small group of MBTSSW administrative and planning staff worked closely with the ADAD team to develop the infrastructure, policies, and procedures for the Hawai‘i CARES call center. On September 12, 2019 Hawai‘i CARES was announced and presented at a legislative briefing held at the Hawai‘i State Capitol, and on October 1, 2019, the Hawai‘i CARES call center began accepting calls from providers and clients. As the call center continues to recruit qualified and competent clinical staff, hours will be scaled up, and the center is projected to be open 24 hours a day, seven days a week by early 2020. Continuous evaluation and improvements will be made by a team of MBTSSW research faculty and staff through provider and community feedback as well as data collected from the call center. The goal is to make data-driven policy and practice improvements to Hawai‘i CARES functions and to evaluate the outcomes related to addiction treatment service accessibility and quality.

Stakeholder Collaborations

Hawai‘i CARES is dependent on collaboration across many agencies and stakeholders. ADAD has been very instrumental in helping to coordinate meetings between the MBTSSW administrators and ADAD providers, clean and sober living homes, state judicial partners, state probation offices, as well as school-based programs that offer addiction services for adolescents. Hawai‘i CARES is continuing to meet and collaborate with providers and other key agencies involved with SUD treatment and recovery services across the state.

Where are We Now?

Hawai‘i CARES officially went live on October 1, 2019 and is now in a pilot phase. In its first two months of operation, the call center has received and placed approximately 1,500 calls; more than 200 clients have undergone screening, intake, and referral via the call center; and more than 1,700 electronic medical record referrals and service authorizations have been exchanged between CARES and service providers. These numbers are projected to grow once CARES is fully operational 24 hours a day, seven days a week.

The call center is open Monday through Friday from 7 a.m. to 5 p.m. We have been able to demonstrate our ability to be responsive and flexible in our process. From day one, we have been able to take calls from clients in need of assessment and put them on the line with local providers who can be immediately dispatched to meet with them. The program is continuing the process of building relationships with service providers across the state and making direct connections with their key team members in an effort to streamline our processes. Moreover, continuous program improvement and evaluation is underway to ensure that decision-making regarding service delivery in the continuum of care is conducted in a data-driven fashion.

Large-scale systems change takes time and adaptations are anticipated along the way. The Ecological Process Model suggests that routinization helps with making changes last overtime.⁹ The pilot phase allows Hawai'i CARES to adapt and implement a routine that meets the needs of those that are involved. As stakeholder buy-in increases and as the coordination processes becomes more fluid and routine, the Hawai'i CARES system will become widespread within the health and welfare community statewide.

For More Information

Hawai'i CARES shares its phone number with the Department of Health Adult Mental Health Division's Crisis Line. For more information on addiction treatment in Hawai'i and referrals to services, please call (808) 832-3100 (Neighbor Island residents, call toll free 1-800-753-6879). And, for more information on Hawai'i CARES, please visit manoa.hawaii.edu/cares.

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