

Native Hawaiian and other Pacific islanders' leading risk factors for ischemic stroke: A comparative ethnographic study

Ryan Ogasawara, BSc,^a Emily Kang,^a
Joseph Among, BSc,^a
Kacie Oyadomari, BSc,^a
Juliette Capitaine, MS,^a
Nicolas Regaspi,^a Pat Borman, MD,^b
Jason Viereck, MD, PhD,^{a,b}
Enrique Carrazana, MD, FAES,^{a,b} and
Kore Kai Liow, MD, FACP, FAAN^{a,b}

Introduction: Hawaii is a multicultural state with many different ethnicities, including Native Hawaiians and other Pacific Islanders (NHOPI). This demographic has not been thoroughly studied, despite its significantly higher prevalence of stroke. This study aimed to characterize risk factors for ischemic stroke in NHOPI compared to other ethnicities. **Methods:** An Institutional Review Board (IRB) sanctioned retrospective chart review was conducted at a multi-site community neurology clinic from June 2017 through June 2019. Prospective patients were identified from the database using the International Classification of Diseases 10th Edition (ICD-10) codes for ischemic stroke. 326 patients (99 NHOPI, 116 Asian, 111 Caucasian) with a history of ischemic stroke met the inclusion criteria. Risk factors were determined based on

Abbreviations: ANOVA, Analysis of Variance; BMI, Body Mass Index; HPN, Hawaii Pacific Neuroscience; ICD-10, International Classification of Diseases 10th Edition; IRB, Institutional Review Board; NHOPI, Native Hawaiian or Other Pacific Islander; QI, Quality Improvement

From the ^aStroke and Neurologic Restoration Center & Stroke Research Unit, Hawaii Pacific Neuroscience, Honolulu, HI USA; and ^bUniversity of Hawai'i at Mānoa, John A. Burns School of Medicine, Honolulu, HI USA.

Received November 26, 2021; revision received February 6, 2022; accepted February 20, 2022.

Corresponding author. E-mail: kliow@hawaiineuroscience.com.

1052-3057/\$ - see front matter

© 2022 Elsevier Inc. All rights reserved.

<https://doi.org/10.1016/j.jstrokecerebrovasdis.2022.106433>

the American Stroke Association guidelines; ethno-racial grouping was based on self-identification; and average household income levels were estimated based on patient zip codes US Census Bureau data. Continuous variable risk factors were analyzed using an analysis of variance (ANOVA) and post-hoc pairwise comparisons using Tukey-Kramer; a multivariate analysis was conducted. **Results:** Compared to Asians and Caucasians, NHOPI patients were on average 11 years younger at the onset of stroke and more likely to be women. The NHOPI group also had the highest rates of diabetes and obesity. NHOPI average income was significantly lower compared to the Caucasian group. Hypertension and hyperlipidemia were found to be higher in the Asian population. Alcohol consumption was reported more frequently among Caucasian patients. **Conclusions:** These results better characterized risk factors for ischemic stroke among NHOPI in Hawaii. The younger age of stroke onset in NHOPI patients is likely due to the higher burden of cardiovascular risk factors like obesity, smoking, and diabetes. Identifying such disparities in associated risk for NHOPI and other ethnicities can allow targeted stroke prevention and outpatient care in a multicultural setting.

Key Words: Ischemic stroke—Cerebrovascular disease—Risk factors—Native Hawaiian—Pacific islander—Hawaii
© 2022 Elsevier Inc. All rights reserved.

Introduction

Cerebrovascular disease or stroke is the third major cause of death in Hawaii.¹ In 2017, about 1 out of every 10 deaths in Hawaii were caused by a stroke, or about 800 deaths that year.¹ Although Hawaii has relatively lower rates of death of stroke compared to half of the other states,¹ a disproportionate number of Native Hawaiians are four times as likely as non-Hispanic Caucasians to be diagnosed with stroke.² Hawaii is a multicultural state, home to many different ethnicities, including Native Hawaiians and other Pacific Islanders (NHOPI). This demographic has not been thoroughly studied, despite the significantly higher prevalence of stroke in this population. NHOPI have been historically aggregated with Asians into a single ethnic group in most prior studies assessing risk factors for ischemic stroke.³ This study characterizes the incidence of specific risk factors for ischemic stroke in Native Hawaiian/other Pacific Islanders (NHOPI) compared to other ethnicities within the context of outpatient care.

Methods

A retrospective chart review with data collection from patients followed at HPN with the diagnosis of ischemic

stroke during June 2017 through June 2019 was conducted. University of Hawai'i at Mānoa, Office of Research Compliance (protocol number: 2020-01010), provided IRB exemption. The study proceeded from a clinical practice quality improvement (QI) retrospective chart review intended to seek detailed insights on symptomatology and risk factors among various neurological diagnoses, including ischemic stroke, and use the results to tailor clinical practice with the purpose of improving clinical services offered. All patient data were de-identified; patient anonymity was assured. Inclusion criteria established prior to data collection were as follows: (1) patients must be hospitalized for a stroke on Oahu, (2) patients must be followed-up by a physician for the finalized diagnosis of ischemic stroke, (3) patients' records must include demographic, clinical history, and follow-up data. Prospective patients were identified from the database using the International Classification of Diseases 10th Edition (ICD-10) codes for ischemic stroke. All codes under the header for ischemic stroke were searched (I63, I65, I66, I67, I68, and I69), and the most common codes collected were I69.393, I69.354, I69.351, I69.30, and I67.89. Risk factors were determined based on the American Stroke Association guidelines; included hypertension, diabetes, body mass index (BMI), hyperlipidemia, heart disease, tobacco use (smoking), alcohol consumption, age, gender, and history of previous cerebrovascular events. Smoking and alcohol use were categorized as none/former consumer and current consumer. Ethnicity and information pertaining to race were collected based on voluntary self-identification during office visits or from other available documents such as hospital records. Average household income levels were estimated based on patient zip codes using data from the 2017 United States Census Bureau.⁴ Area-based socioeconomic status indicators, such as zip code average household income, have been shown to be best suited to monitor health care disparities.⁵ HPN has comprehensive medical records on all its patients, including hospital charts and admission records. In addition, comprehensive histories and follow up are also independently taken at HPN using a multidisciplinary team approach. Patient's risk factors were thus obtained using a manual review of each patient's records, which were supplemented by chart abstraction from hospitals when necessary.

In the primary analysis, continuous variable risk factors were analyzed using an analysis of variance (ANOVA) and post-hoc pairwise comparisons using Tukey-Kramer; all other categorical variables were analyzed using Chi-squared analysis with post-hoc pairwise comparisons between each ethnicity. In the multivariate analyses, three separate logistic regression models were developed to compare 1) NHOPI with Caucasian, 2) Asian with Caucasian, and 3) NHOPI and Asian. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated from the β coefficients and their standard errors. The R Foundation

for Statistical Computing software - version 3.6.2 (R Foundation for Statistical Computing, Vienna, Austria) was used for statistical analysis.

Results

Of the 363 medical records reviewed, 326 patients met the inclusion criteria. 30% self-identified as NHOPI (N = 99), 36% as Asian (N = 116), and 34% as Caucasian (N = 111). Primary analysis showed statistically significant differences in age, median household income, gender, obesity, hypertension, diabetes, hyperlipidemia, alcohol consumption, and BMI based on ethnicity (Table 1). NHOPI patients were, on average, 11 years younger at the onset of stroke, and they were more likely to be women (52.5%), whereas Asian and Caucasian patients were predominantly men (59.5% and 64%, respectively). Results were notable for NHOPI being significantly more obese than Asians and Caucasians, followed by higher rates of comorbidities like diabetes and hypertension. The most significant differences between ethnicities were diabetes and BMI ($P < 0.001$). Both risk factors were the most prevalent in the NHOPI. It is also significant that the average household income of NHOPI patients is \$8000 lower than the income of Caucasian patients. The Asian population had the highest rate of hypertension ($P = 0.0079$) and hyperlipidemia ($P = 0.0436$), compared to NHOPI and Caucasians. Alcohol use was highest among Caucasian subjects ($P=0.002$).

All results from logistic regression models are shown in Table 2. NHOPI were less likely to be male (OR 2.47, 95% CI 1.27- 4.94), more likely to have diabetes (OR 0.30, 95% CI 0.15-0.59), and less likely to consume alcohol (OR 2.74, 95% CI 1.11-7.22) than Caucasians. In the logistic regression model, Asians were less likely to be obese (OR 0.15, 95% CI 0.06-0.33), more likely to have hypertension (OR 3.13, 95% CI 1.33-7.70), and diabetes (OR 2.05, 95% CI 1.04-4.17), and less likely to consume alcohol (OR 0.22, 95% CI 0.08-0.52) than Caucasians. Finally, NHOPI were younger (OR 1.04, 95% CI 1.02-1.07), more obese (OR 0.21, 95% CI 0.09-0.47), and more likely to have coronary artery disease (OR 0.42, 95% CI 0.21-0.83) than Asians.

Discussion

There are a variety of established risk factors contributing to stroke, including arterial hypertension, hyperlipidemia, diabetes, smoking, and alcohol consumption, which are not equally shared between ethnicities due to genetic and cultural modulation.^{6,7} Other risk factors include age and gender, as well as personal and family history. Higher income is positively correlated with improved longevity, which may be due to better access to healthcare, information, and healthy lifestyle options.⁸ Moreover, it is estimated that about 80% of all strokes could be prevented through improved management of risk factors.⁹

Table 1. Demographics and risk factors of ischemic strokes by ethnicity.

Patient demographics and risk factors	Overall Statistical Significance (p-value)	NHOPI	Asians	Caucasians
Number of patients		99	116	111
Age	< 0.001	62 ± 14 ^a	73 ± 14 ^b	73 ± 13
Median Income, \$	0.003	84310 ± 16300 ^a	89073 ± 17000	92561 ± 18000
Gender				
Men	0.046	47 (47.5%) ^a	69 (59.5%)	71 (64.0%)
Women		52 (52.5%) ^a	47 (40.5%)	40 (36.0%)
Obesity	< 0.001	47 (47.5%) ^a	12 (10.3%) ^{a, b}	31 (28.0%)
BMI, kg/m ²	< 0.001	31.9 ± 9 ^a	25 ± 4 ^{a, b}	27 ± 5
Hypertension	0.008	85 (85.9%)	104 (89.7%) ^a	83 (74.8%)
Diabetes mellitus	< 0.001	52 (52.5%) ^a	43 (37.1%) ^{a, b}	25 (22.5%)
Hyperlipidemia	0.044	75 (75.8%)	95 (81.9%) ^a	75 (67.6%)
Coronary artery disease or prior MI	0.089	43 (43.4%)	37 (31.9%)	50 (45.0%)
Previous stroke or TIA	0.794	50 (51.5%)	58 (50.0%)	49 (44.1%)
Smoking	0.322	14 (14.2%)	9 (7.8%)	12 (10.8%)
Alcohol	0.002	11 (11.1%)	8 (6.9%) ^a	25 (22.5%)

Abbreviations: BMI = body mass index; MI = myocardial infarction; NHOPI = Native Hawaiians or other Pacific Islanders; TIA = transient ischemic attack.

Data are n (%) or mean ± SD.

^apairwise p < 0.05 compared with Caucasians

^bpairwise p < 0.05 compared with NHOPI

In our study, NHOPI patients showed a higher index for obesity, diabetes mellitus, and BMI compared to other racial groups. The variations in ischemic stroke risk factors among Asians, Caucasians, and NHOPI that were observed in outpatients are consistent with prior reports of acute stroke inpatients.^{3,10} These studies complement our study in terms of the patient population of outpatient and inpatients. An unhealthy diet and poor nutrition are risk factors for obesity, diabetes, and high blood pressure.¹¹ A partial explanation for why these risk factors tend to occur more often in the NHOPI could be caused by the adaptation of the Westernized diet and sedentary lifestyle.³ Hypertension and hyperlipidemia are significant risk factors for the Asian population in Hawaii; this is consistent with a previous meta-analysis of studies conducted in Asian countries (China, Taiwan, and Mongolia).¹² Hypertension and hyperlipidemia are nevertheless also prevalent risk factors for the NHOPI community and are interrelated to obesity and diabetes.¹³

NHOPI women showed a higher incidence of ischemic stroke in comparison with Caucasian women. It has been reported that NHOPI women have a lower resting metabolic rate than Caucasian women¹⁴ which may contribute to the significant risk factors for obesity, higher BMI, and consequently, stroke. Obesity and physical inactivity are common stroke risk factors for females shared across the various Pacific Islander communities across Oceania.¹⁵

Our NHOPI population has the highest smoking rates among the ethnicities. A higher prevalence of tobacco use compared to Asian Americans has been reported in the

general population.¹⁶ Ignorance or lack of culturally appropriate smoking cessation resources could be the cause of this health risk disparity. In contrast, our NHOPI population did not have the highest alcohol consumption in comparison to Asians and Caucasians. Consistent with other reports, the highest prevalence of alcohol consumption among our stroke patients was Caucasians, with Asians having the lowest.¹⁷ Important to note that Hawaii has about 30% higher prevalence of 'heavy drinking' than that for the general US population.¹⁸ Therefore, excessive alcohol consumption cannot be discarded as a target risk factor for the NHOPI population.

NHOPI average income was significantly lower compared to the Caucasian group. Certain risk factors significant to NHOPI, such as obesity and diabetes, may be related to barriers of low-income level groups, including lack of social support, access to health care, knowledge of treatment, and unhealthy diet.¹⁹ This study's results further underscore the importance of focusing on social determinants and community health aspects when addressing risk factors for ischemic strokes.

NHOPI patients presented with a stroke on average 11 years earlier than their counterparts, and this observation has been captured by other studies.^{10,20} The younger age of stroke onset in NHOPI patients is likely due to the higher burden of cardiovascular risk factors, i.e., high BMI, obesity, and diabetes. Younger onset of stroke versus Caucasian peers has also been reported in Maoris from New Zealand, a minority population with an analogous history to Native Hawaiians (21). Maori population

Table 2. Multivariable logistic regression models.

Patient demographics and risk factors	NHOPI and Caucasian OR (95% CI)	Asian and Caucasian OR (95% CI)	NHOPI and Asian OR (95% CI)
Age	1.07 (1.04-1.10) ^a	0.98 (0.96-1.01)	1.04 (1.02-1.07) ^a
Male sex	2.47 (1.27- 4.94) ^a	0.85 (0.44-1.62)	1.53 (0.80-2.96)
Obesity ^b	1.10 (0.54- 2.30)	0.15 (0.06-0.33) ^a	0.21 (0.09-0.47) ^a
Hypertension	0.56 (0.22-1.34)	3.13 (1.33-7.70) ^a	1.46 (0.52-4.06)
Diabetes mellitus	0.30 (0.15-0.59) ^a	2.05 (1.04-4.17) ^a	0.70 (0.36-1.36)
Hyperlipidemia	0.90 (0.42-1.93)	1.59 (0.77-3.31)	1.53 (0.66-3.54)
Coronary artery disease or prior MI	0.73 (0.37-1.42)	0.64 (0.33-1.22)	0.42 (0.21-0.83) ^a
Previous stroke or TIA	0.70 (0.27-1.80)	1.00 (0.40-2.57)	0.87 (0.33-2.26)
Smoking	1.48 (0.52-4.21)	0.65 (0.23-1.81)	0.92 (0.31-2.71)
Alcohol	2.74 (1.11-7.22) ^a	0.22 (0.08-0.52) ^a	0.52 (0.16-1.63)

Abbreviations: BMI = body mass index; MI = myocardial infarction; NHOPI = Native Hawaiians or other Pacific Islanders; TIA = transient ischemic attack; OR = odds ratio.

^aORs were statistically significant at $p < 0.05$.

^bObesity = body mass index $> 30 \text{ kg/m}^2$.

shares some of the same risk factors as our NHOPI population, e.g., hypertension, cardiac disease, diabetes, hypercholesterolemia, smoking, obesity.²¹

Reasons for racial disparities in ischemic strokes are numerous and sometimes difficult to explain. One study suggests that while disparities in stroke risk factors among racial groups might arise due to genetic factors, such as C-reactive protein polymorphisms, gene-environment interactions also play an important role.⁸ Furthermore, there is evidence of disparities in stroke characteristics/risk factors even within the NHOPI grouping, suggesting that there are significant gene-environment interactions beyond genetic differences that can change an individual's risk level for stroke.^{3,7} Furthermore, there is also an increasing acceptance in the literature that race is a social construct.²² As such, these disparities in stroke risk factors and health outcomes can also be attributed to differences and inequalities in the social aspects of the race. For example, it has been shown that NHOPI suffer a disproportionate number of poor health outcomes such as obesity and hypertension compared with Caucasians and Asians due to social and financial barriers to health care access.²³ It has been suggested that risk factors and prevalence of ischemic stroke may differ between Asians living in Asia and Asian Americans living in the United States due to regional diets, environmental factors, or cultural divergence.²⁴ Hawaii's Asian majority demographics and strong cultural ties could be minimizing the divergence of stroke risk factors among its Asian population.

This study has several limitations. First, ethnicities were obtained via standard questionnaire answered voluntarily during visits to Hawaii Pacific Neuroscience which can be subjective given the high prevalence of interracial mixing and multiethnic populations in Hawaii. Second, smoking and alcohol consumption were also self-reported and have the potential to under-estimate (or over-estimate)

patients' habits. Third, this study has the limitation of a single-center study; however, HPN takes all types of insurance policies and patients with no medical insurance, welcoming the economically disadvantaged patient population. HPN has a primary center in Honolulu and satellite centers across the state, taking in patients discharged from multiple hospitals, which may help with issues of generalizability. Because our center is an outpatient Neurology center, there might have been referral bias toward stroke of less severity and less extensive comorbidities. Lastly, though the research team retrieved data of patients of other ethnicities such as Hispanic and African American, those were excluded from the study due to insufficient representation.

Conclusion

Future studies could explore potential differences between NHOPI and their counterparts in different geographies than Hawaii. For example, states like California, Washington, Utah, and Nevada are known to have relatively large populations of NHOPI constituents. Thus, understanding differences in the level of stroke risk of NHOPI, a key ethnographic group in the State of Hawaii, will allow a more tailored approach targeting this understudied ethnocultural racial group and leading towards better stroke prevention and post-stroke care.

Funding

None

Conflicts of interest

The authors declare the absence of any commercial or financial construing as a potential conflict of interest.

Availability of data and material (data transparency)

The raw data supporting the conclusions of this article can be made available by the authors without undue reservation.

Code availability

(software application or custom code): Not applicable

Authors' contributions

Development: RO, EK, JA, KO, JC, NR, PB; Data Collection: RO, EK, JA, KO, JC, NR; Analysis and Interpretation of Data: RO, EK, PB, JV, EC, KKL; Writing of Manuscript: RO, EK, JC, NR, JV, EC; Manuscript Approval/Editing: PB, JV, EC, KKL.

Ethics approval

Institutional review board exemption; University of Hawaii at Mānoa, Office of Research Compliance (protocol number: 2020-01010)

Consent to participate

Not applicable.

Consent for publication

All authors approved the submitted manuscript version.

Acknowledgments: We would like to thank Catherine Mitchell and Ena Zhu, as well as other staff at Hawaii Pacific Neuroscience, for their time in providing valuable administrative support.

References

- Centers for Disease Control and Prevention. (2018, April 13). *Stats of the State of Hawaii*. Centers for Disease Control and Prevention. <https://www.cdc.gov/nchs/pressroom/states/hawaii/hawaii.htm>.
- The Office of Minority Health. Stroke and Native Hawaiians/Pacific Islanders Table A-1a. Summary Health Statistics: National Health Interview Survey 2014 <https://minorityhealth.hhs.gov/omh/browse.aspx?lvl=4&lvlid=88>.
- Nakagawa K, MacDonald PR, Asai SM. Stroke Disparities: Disaggregating Native Hawaiians from other Pacific Islanders. *Ethn Dis* 2015 Spring;25:157-161. PMID: 26118142.
- U.S. Census Bureau. Households-Median Income (Dollars)-Estimate 2017. Retrieved on 27 December 2020 from https://data.census.gov/cedsci/map?t=Income%20%28Households,%20Families,%20Individuals%29&tid=ACST5Y2017.S1901&vintage=2017&layer=VT_2017_860_00_PY_D1&cid=S1901-C01_012E&mode=thematic.
- Berkowitz SA, Traore CY, Singer DE, Atlas SJ. Evaluating area-based socioeconomic status indicators for monitoring disparities within health care systems: results from a primary care network. *Health Serv Res* 2015;50:398-417. <https://doi.org/10.1111/1475-6773.12229>.
- Aldayel YA, Alharbi MM, Shadid MA, Zevallos CJ. The Association between race/ethnicity and the prevalence of stroke Among United States Adults in 2015: a Secondary Analysis Study Using Behavioural Risk Factor Surveillance System (BRFSS). *Electr Phys* 2017;9:5871-5876. <https://doi.org/10.19082/5871>.
- Boehme A, Esenwa C, Elkind M. Stroke risk factors, genetics, and prevention. *Circ Res* 2017;120:472-495. <https://doi.org/10.1161/circresaha.116.308398>.
- Chetty R, Stepner M, Abraham S, Lin S, Scuderi B, Turner N, Bergeron A, Cutler D. The association between income and life expectancy in the United States, 2001-2014. *JAMA* 2016;315:1750-1766. <https://doi.org/10.1001/jama.2016.4226>.
- American Stroke Association. American Stroke Month Secondary Prevention. (n.d.). Retrieved January 06, 2021, from <https://www.stroke.org/en/about-the-american-stroke-association/american-stroke-month-secondary-prevention>
- Nakagawa K, Koenig M, Asai S, Chang C, Seto T. Disparities among Asians and Native Hawaiians and Pacific Islanders with Ischemic Stroke. *Neurology* 2013;80:839-843. <https://doi.org/10.1212/wnl.0b013e3182840797>.
- Office of Disease Prevention and Health Promotion. Access to Foods that Support Healthy Eating Patterns. (2020). Retrieved 27 December 2020, from <https://www.healthypeople.gov/2020/topics-objectives/topic/social-determinants-health/interventions-resources/access-to-foods-that-support-healthy-eating-patterns>
- Cui Q. Modifiable and non-modifiable risk factors in ischemic stroke: a meta-analysis. *Afr Health Sci* 2019;19:2121. <https://doi.org/10.4314/ahs.v19i2.36>.
- Stavig GR, Igra A, Leonard AR. Hypertension and related health issues among Asians and Pacific Islanders in California. *Pub Health Rep* 1988;103(1):28-37.
- Grandinetti A, Chang HK, Chen R, Fujimoto WY, Rodriguez BL, Curb JD. Prevalence of overweight and central adiposity is associated with percentage of indigenous ancestry among native Hawaiians. *Int J Obesity Rel Metab Disorders* 1999;23(7):733 <https://doi.org/10.1038/sj.ijo.0800921>.
- Venkatasubramanian N. Stroke epidemiology in oceania: a review. *Neuroepidemiology* 2021;55:1-10. <https://doi.org/10.1159/000512972>.
- Nguyen AB. Disaggregating Asian American and Native Hawaiian and Other Pacific Islander (AANHPI) Adult Tobacco Use: Findings from Wave 1 of the Population Assessment of Tobacco and Health (PATH) Study, 2013-2014. *J Racial Ethnic Health Disparities* 2009;6(2):356-363. <https://doi.org/10.1007/s40615-018-00532-1>.
- Chartier K, Caetano R. Ethnicity and health disparities in alcohol research. *Alcohol Res Health* 2010;33(1-2):152-160.
- Remigio-Baker RA, Hayes DK, Reyes-Salvail F. The relationship of adverse childhood events to smoking, overweight, obesity and binge drinking among women in Hawaii. *Matern Child Health J* 2017;21(2):315-325. <https://doi.org/10.1007/s10995-016-2116-8>. PMID: 27449778.
- Beckett J, Barley J, Ellis C. Patient perspectives of barriers and facilitators of treatment-seeking behaviors for stroke care. *J Neurosci Nursing* 2015;47:154-159. <https://doi.org/10.1097/jnn.0000000000000134>.

20. Nakagawa K, Ito S, King S. Ethnic comparison of clinical characteristics and ischemic stroke subtypes among young adult patients with stroke in Hawaii. *Stroke* 2017;48:24-29. <https://doi.org/10.1161/strokeaha.116.014618>.
21. Feigin V, Carter K, Hackett M, et al. Ethnic disparities in incidence of stroke subtypes: Auckland Regional Community Stroke Study, 2002–2003. *Lancet Neurol* 2006;5:130-139.
22. Yudell M, Roberts D, DeSalle R, Tishkoff S. Taking race out of human genetics. *Science* 2016;351:564-565. <https://doi.org/10.1126/science.aac4951>.
23. Morisako AK, Tauali'i M, Ambrose A, Withy K. Beyond the ability to pay: the health status of Native Hawaiians and other pacific islanders in relationship to health insurance. *Hawaii J Med Public Health* 2017;76(3 Suppl 1):36-41. PMID: 28435757.
24. Takeya Y, Popper J, Shimizu Y, Kato H, Rhoads G, Kagan A. Epidemiologic studies of coronary heart disease and Stroke in Japanese men living in Japan, Hawaii and California: incidence of stroke in Japan and Hawaii. *Stroke* 1984;15(1):15-23. <https://doi.org/10.1161/01.str.15.1.15>.