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The Relationship Between Medication Adherence and Total Healthcare Expenditures by Race/Ethnicity in Patients with Diabetes in Hawai'i

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Her manuscript, entitled "The Relationship Between Medication Adherence and Total Healthcare Expenditures by Race/Ethnicity in Patients with Diabetes in Hawai'i," compared total annual healthcare expenditures of patients with diabetes in Hawai'i by race and ethnicity and determined whether any existing differences persisted after controlling for medication adherence and demographic factors. Filipinos, Native Hawaiians, and Other Pacific Islanders were found to have significantly lower medication adherence rates compared to other groups. These ethnic groups also had the lowest median healthcare costs. Generalized linear regression models showed that after controlling for demographic factors and medication adherence, Japanese, Chinese, Filipinos,

and Native Hawaiians had significantly lower total healthcare costs compared to Caucasians. Costs for Other Pacific Islanders were not significantly different from those of Caucasians. This study provides evidence that total health-related cost is associated with a multitude of factors that further research may reveal.

Abstract

Diabetes is a costly, chronic disease that is becoming increasingly prevalent worldwide. Studies show that Native Hawaiians suffer from higher rates of diabetes and lower rates of medication adherence compared to Caucasians and Japanese. This study compared total annual healthcare expenditures of patients with diabetes in Hawai'i by race and ethnicity and determined whether any existing differences persisted after controlling for medication adherence and demographic factors. The study population consisted of 30,445 individuals, using administrative claims data from a large health plan in Hawai'i. Filipinos, Native Hawaiians, and Other Pacific Islanders had significantly lower medication adherence rates compared to other groups. These ethnic groups also had the lowest median healthcare costs. In contrast, Caucasians had one of the highest medication adherence rates coupled with the highest median annual healthcare expenditures at \$5,132. Generalized linear regression models showed that after controlling for demographic factors and medication adherence, Japanese (RR=0.86, 95%CI [0.78, 0.94]), Chinese (RR=0.83, 95%CI [0.73, 0.95]), Filipinos (RR=0.74, 95%CI [0.67, 0.82]), and Native Hawaiians (RR=0.74, 95%CI [0.67, 0.82]) had significantly lower total healthcare costs compared to Caucasians. Costs for Other Pacific Islanders were not significantly different from those of Caucasians. This study provides evidence that total health-related cost is associated with a multitude of factors that further research may reveal.

Keywords

Native Hawaiian health, diabetes, medication adherence, total healthcare cost, health disparities

Introduction

Diabetes is one of the most common chronic conditions in the United States, affecting nearly 29.1 million people nationwide with an annual cost, including direct medical costs and indirect costs from lost wages, of \$245 billion in 2014.¹ Between 2011 and 2015, 8.6% of individuals, or on average 93,560 people in Hawai'i, suffered from diabetes.² It is a debilitating disease that can lead to a variety of serious complications, including neuropathy, cardiovascular disease, and renal failure.³ Several studies have shown that important risk factors for diabetes include obesity and hypertension, which can also lead to an increased risk for comorbid conditions such as congestive heart failure (CHF) and coronary artery disease (CAD).⁴⁻¹⁰

Diabetes prevalence differs by race and ethnicity. The Behavioral Risk Factor Surveillance System (BRFSS) data shows that diabetes prevalence from 2011-2015 is higher among Native Hawaiians (10.7%), Other Pacific Islanders (9.1%), Filipinos (10.5%), Japanese (11.7%), and Chinese (8.8%), as compared to Caucasians (5.1%).¹¹ Historically, researchers grouped Asian Americans and Pacific Islanders into a single race category (Asian/Pacific Islanders [API]). However, several studies have shown that these populations exhibit significant disparities in diabetes prevalence.¹² For example, studies suggest that Native Hawaiians, Other Pacific Islanders, and Southeast Asians such as Filipinos have a higher prevalence of diabetes compared to

East Asian groups such as Japanese and Chinese. Caucasians generally have lower diabetes prevalence compared to all other racial and ethnic groups.¹³⁻¹⁴ These differences may be associated with demographic and environmental factors.¹⁵ For example, low socioeconomic status and education level have been linked to higher diabetes prevalence in multiple studies.¹⁶ Additionally, there are some factors such as higher medication adherence, that are associated with less serious complications and lower healthcare costs.¹⁸⁻²¹ Studies have shown that Native Hawaiians, Other Pacific Islanders, and Filipinos have lower rates of medication adherence compared to Caucasians and Japanese.¹⁷

To our knowledge, there are no published studies examining the impact of medication adherence on total healthcare costs for patients with diabetes by race/ethnicity.^{3,22} The goals of this study were to (1) examine differences in total health care costs by race and ethnicity in Hawai'i and (2) to determine the relationship between medication adherence and total overall health care costs. We hypothesize that total healthcare expenditures will vary between different races and ethnicities, and that higher medication adherence is associated with fewer negative health outcomes and lower cost of healthcare.

Methods

We analyzed administrative claims data from 2007-2010 for adults aged 18 years or older with diabetes enrolled in a large health insurance company in Hawai'i (N=30,445). Patients with diabetes were identified as anyone with a pharmacy claim for dispensed insulin or oral hypoglycemic or antihyperglycemics or at least two face-to-face encounters with a diagnosis of diabetes (ICD-9 codes 250, 357.2, 366.41, 648.0). Comorbid conditions CAD and CHF were also determined by the health plan using ICD-9 codes 414.01 and 428.0, respectively, and were included because they are known to be associated with higher costs of care for patients with diabetes. All-cause patient morbidity was estimated by the health plan using ICD-9-CM diagnostic codes according to the Johns Hopkins Adjusted Clinical Group methodology. A score of 4 or 5 on a 5-point scale was categorized as high morbidity. These scores were assigned by the health insurance company.²³

Race/ethnicity was based on self-report from member satisfaction surveys. Race/ethnicity was categorized for the six most common ethnic groups in Hawai'i (Japanese, Native Hawaiian, Caucasian, Filipino, Chinese, other Pacific Islanders). Other Pacific Islanders were defined as from a Pacific Island other than Hawai'i. If a patient reported more than one racial or ethnic group, they were considered "mixed race". The exception was Native Hawaiians; if individuals identified as Native Hawaiian along with another race or ethnicity, they were categorized as Native Hawaiian. Patients of "mixed" race or ethnicity who were not Native Hawaiian and those of other race were excluded from analyses.

Medication adherence was calculated based on medication possession ratios (MPR) for three types of medications (anti-diabetic, cholesterol lowering, anti-hypertensive). Using the medication name, days' supply, and date the medication was

filled for each prescription, the MPR was calculated as the ratio of the number of days for which a patient has medication in their possession divided by the total number of days a patient was enrolled in a drug plan. If a patient had data for more than one year, medication adherence was averaged to give a single MPR for each type of medication for every patient. The MPR ranges between 0 and 1, with 1 representing perfect adherence. For the purposes of this study, we defined adherence as an MPR of at least 0.8, or an 80% possession ratio. Thresholds between 75 and 80% are commonly used in literature when evaluating medication adherence.²⁴ The MPR has often been used to measure adherence for medications that require long-term use.²⁵

The primary outcome for this analysis was total annual health care costs. Total costs were calculated by summing inpatient, outpatient, and prescription costs and included the amount paid by the health plan and the patient copayment on an annual basis at the individual patient level. All costs were converted to 2010 dollars using the medical component of the consumer price index. Total health expenditures are also summarized in a violin plot that captures the range and distribution of costs by race and ethnicity.

Statistical Analyses

For descriptive analyses, the median total healthcare expenditures for each race/ethnicity were calculated and compared using Wilcoxon rank sum tests. Demographic characteristics, medication adherence rates, CAD and CHF prevalence, and number of hospital and emergency department (ED) visits were compared across race/ethnicities using chi-squared or t-tests, as appropriate. Multivariable generalized linear models with log-link function were used to estimate differences in health care costs related to race/ethnicity, assuming that health care cost variable is Gamma distributed. The first model included only race/ethnicity dichotomous variables, with Caucasians as the comparison group. The adjusted model added medication adherence and demographic characteristics including age, gender, region (by zip code), history of CAD or CHF, high morbidity, and whether or not the patient expired during the year. Rate ratios with 95% confidence intervals were calculated using STATA V13 (College Station, TX). The study was given exempt status by the University of Hawai'i Institutional Review Board.

Results

The study population consists of a total of 30,445 participants with diabetes, of which 44.3% are Japanese, 19.7% are Filipino, 18.4% are Native Hawaiian, 9.6% are Caucasian, 6.9% are Chinese, and 1.2% are Other Pacific Islanders. Table 1 summarizes the population demographics. Chinese had the highest mean age at 65.9 (SD=11.7) years. The mean average age for all other ethnicities ranged from 56.1 to 65.4 years. Caucasians had the highest overall patient morbidity from all-causes and CAD prevalence at 42.8% and 27.3%, respectively. In contrast, a lower proportion of Other Pacific Islanders had high morbidity (32.3%) and CAD prevalence (21.2%). Native Hawaiians had the highest CHF prevalence (15.8%), while Chinese had the lowest CHF prevalence (9.5%).

Medication Adherence

Figure 1 shows medication adherence by race/ethnicity and type of medication. Overall, individuals from each race/ethnicity were most adherent to anti-hypertensive medication, followed by anti-diabetic medication, and least adherent to cholesterol lowering medication. Japanese had the highest adherence to oral anti-diabetic medication at 60.4%, while Other Pacific Islanders had the lowest (43.2%). Native Hawaiians, Other Pacific Islanders, and Filipinos had significantly lower adherence rates for each medication compared to other groups.

Total Healthcare Expenditures

Figure 2 shows median annual total healthcare expenditures among patients with diabetes by race/ethnicity. Caucasians had the highest median healthcare cost at \$5,132 per year, followed by Chinese (\$4,243) and Japanese (\$4,121). Native Hawaiians, Other Pacific Islanders, and Filipinos had

significantly lower annual healthcare costs at \$4,115, \$3,360, and \$3,305, respectively. Figure 3 shows the total healthcare expenditures in a violin plot, adjusted for demographic factors, including age, sex, region of residence, CAD prevalence, CHF prevalence, and high morbidity prevalence. While Caucasians still have the highest adjusted median healthcare expenditures, the interquartile (25th to 75th) range of each race/ethnicity is relatively similar. There are a few Native Hawaiians with large total healthcare expenditures, compared to other groups, which is not evident in Figure 2.

Controlling for Medication Adherence

Table 2 summarizes the results of three generalized linear models. In the unadjusted model (model 1), Japanese (RR=0.82, 95% CI [0.74,0.90]), Chinese (RR=0.87, 95% CI [0.82,0.98]), and Filipinos (RR=0.69, 95% CI [0.62,0.76]) had significantly lower total health costs compared to Caucasians, while Native Hawaiians

	Japanese (n = 13,485)	Filipino (n = 5,989)	Chinese (n = 2,092)	Caucasian (n = 2,932)	Native Hawaiian (n = 5,588)	Other Pacific Islander (n = 359)	P-value
Mean Age (years) (SD)	65.4 (11.6)	62.0 (11.5)	65.9 (11.7)	62.4 (10.6)	60.2 (11.6)	56.1 (11.6)	<.001
Female	7,146 (53.0%)	3,430 (57.3%)	1,075 (51.4%)	1,305 (44.5%)	3,011 (53.9%)	176 (49.0%)	<.001
High Morbidity	4,864 (36.1%)	1,955 (32.6%)	772 (36.9%)	1,254 (42.8%)	2,064 (36.9%)	116 (32.3%)	<.001
CAD	3,350 (24.8%)	1,319 (22.0%)	647 (30.9%)	800 (27.3%)	1,497 (26.8%)	76 (21.2%)	<.001
CHF	1,259 (9.3%)	636 (10.6%)	198 (9.5%)	352 (12.0%)	882 (15.8%)	37 (10.3%)	<.001
>1 ED Visit	243 (1.8%)	53 (0.89%)	33 (1.6%)	44 (1.5%)	59 (1.1%)	2 (0.56%)	<.001
>1 Hospital Visit	778 (5.8%)	331 (5.5%)	111 (5.3%)	200 (6.8%)	397 (7.1%)	25 (7.0%)	<.001

CAD = coronary artery disease, CHF = congestive heart failure, ED = emergency department

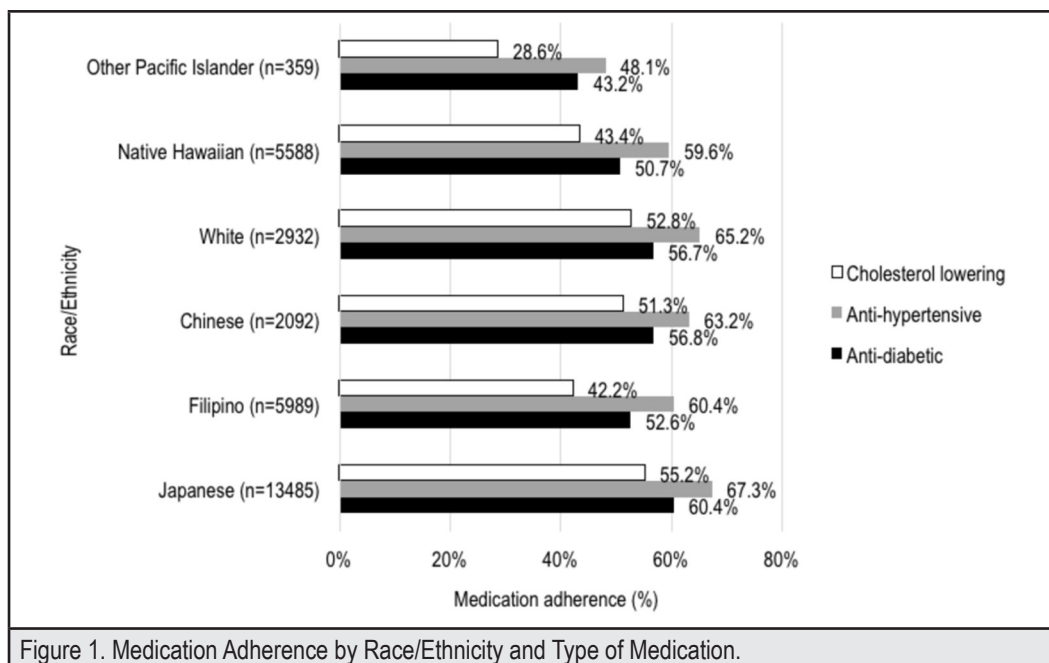


Figure 1. Medication Adherence by Race/Ethnicity and Type of Medication.

(RR=0.91, 95% CI [0.82, 1.02]) and Other Pacific Islanders (RR=1.1, 95% CI [0.79, 1.34]) did not significantly differ from Caucasians. In Model 2, demographic factors (specified above) were added to the model. In this model, Chinese, Japanese, and Filipinos still showed significantly lower total healthcare costs than Caucasians. Native Hawaiians had significantly lower total healthcare costs (RR=0.89, 95% CI [0.82, 0.98]). Other Pacific Islanders remained statistically non-significant from Caucasians in terms of healthcare costs. Model 3 includes the addition

of medication adherence. Total healthcare expenditures for Japanese, Chinese, Filipinos, and Native Hawaiians remained statistically lower compared to Caucasians. Adherence to cholesterol-lowering medication was significantly associated with total healthcare cost (RR=0.93, 95% CI [0.87, 0.99]), while adherence to oral anti-diabetic medication (RR=0.97, 95% CI [0.91, 1.03]) and anti-hypertension medication (RR=0.94, 95% CI [0.88, 1.00]) were not statistically associated.

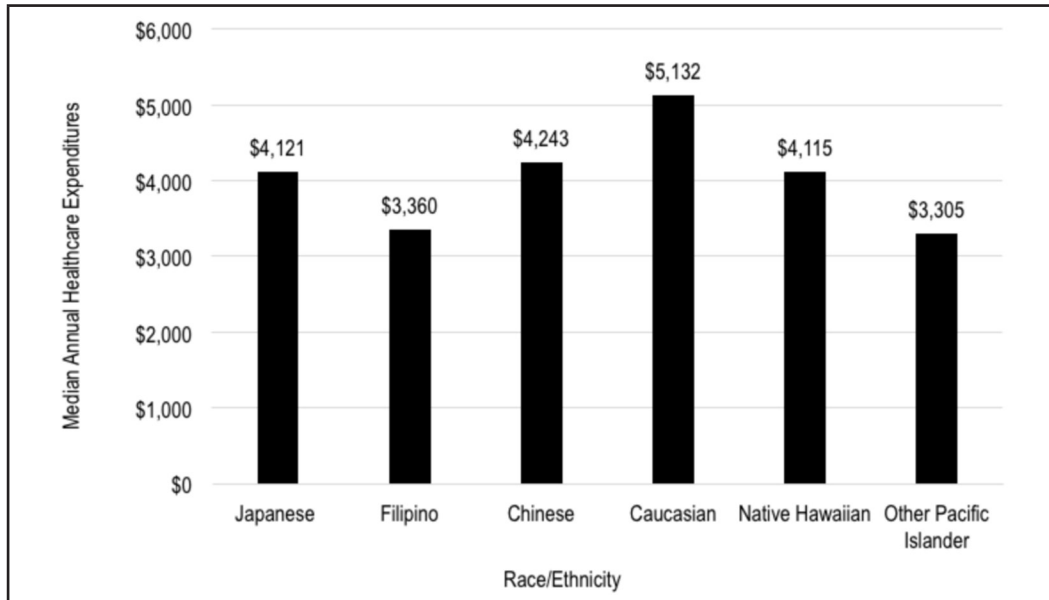


Figure 2. Median Total Healthcare Expenditures by Race/Ethnicity, Unadjusted.

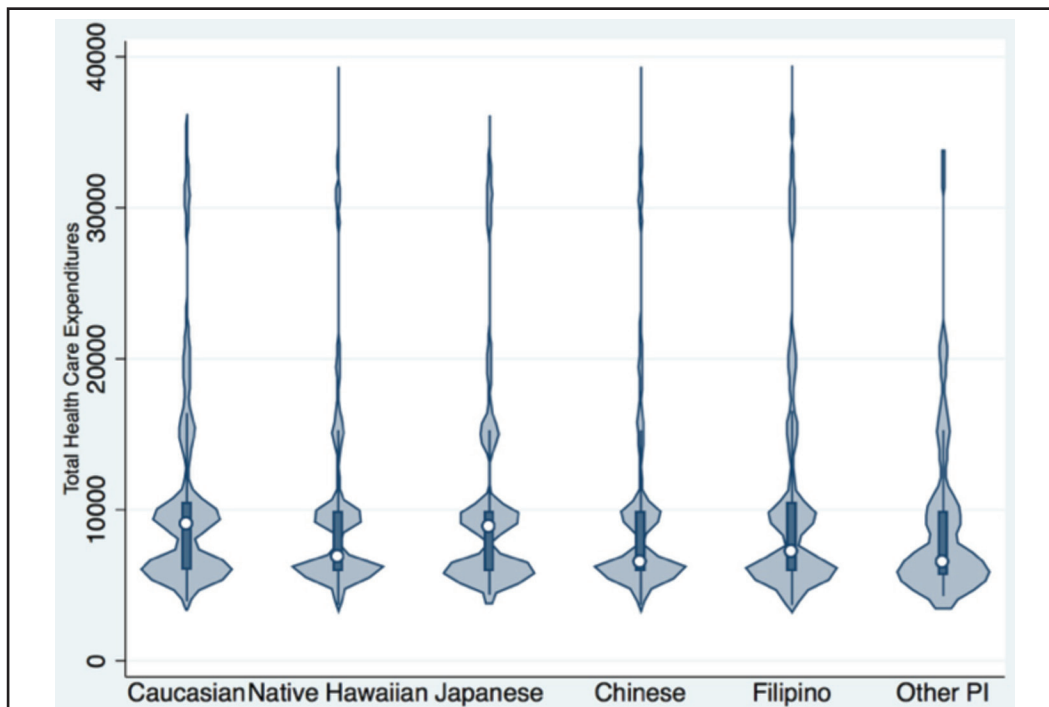


Figure 2. Median Total Healthcare Expenditures by Race/Ethnicity, Unadjusted.

Note: For this violin plot, the circle shows the median, the rectangle is the interquartile range, the lengths show the range, and the width is the estimated kernel density. PI = Pacific Islander.

Table 2. Total Healthcare Expenditures Related to Race and Ethnicity, Demographic Characteristics, and Medication Adherence.**			
	Model 1 (Race/ethnicity only)	Model 2 (Race/ethnicity + demographics)	Model 3 (Race/ethnicity + demographics + medication adherence)
Race/ethnicity			
Caucasian	1	1	1
Japanese	0.82 [0.74,0.90]*	0.89 [0.82,0.98]*	0.86 [0.78,0.94]*
Chinese	0.87 [0.76,0.99]*	0.87 [0.77,0.98]*	0.83 [0.73,0.95]*
Filipino	0.69 [0.62,0.76]*	0.70 [0.64,0.77]*	0.74 [0.67,0.82]*
Native Hawaiian	0.91 [0.82,1.02]	0.89 [0.82,0.98]*	0.89 [0.80,0.99]*
Other Pacific Islander	1.1 [0.79,1.34]	1.1 [0.88,1.39]	1.0 [0.78,1.31]
Age			
<35		1	1
35-49		0.77 [0.61,0.96]*	0.77 [0.53,1.14]
50-64		0.98 [0.79,1.22]	0.96 [0.66,1.40]
65+		1.01 [0.81,1.26]	0.94 [0.64,1.37]
Female		0.94 [0.90,0.98]*	0.93 [0.89,0.98]*
Region			
Honolulu		1	1
East Hawai'i		0.92 [0.84,1.00]	0.94 [0.85,1.04]
West Hawai'i		1.03 [0.92,1.16]	1.00 [0.88,1.15]
Kaua'i		0.99 [0.90,1.09]	0.99 [0.89,1.10]
Maui		1.09 [0.99,1.20]	1.02 [0.92,1.13]
O'ahu other		1.07 [1.01,1.13]*	1.01 [0.95,1.08]
Other region		0.99 [0.81,1.22]	0.98 [0.79,1.22]
Coronary Artery Disease		1.58 [1.49,1.68]*	1.55 [1.45,1.65]*
Congestive Heart Failure		1.99 [1.84,2.16]*	1.93 [1.77,2.10]*
High morbidity		1.54 [1.47,1.62]*	1.43 [1.35,1.51]*
Deceased		3.07 [2.36,4.00]*	2.98 [2.24,3.96]*
Adherence			
Anti-diabetic			0.97 [0.91,1.03]
Anti-hypertensives			0.94 [0.88,1.00]
Cholesterol lowering			0.93 [0.87,0.99]*

*Indicates significance.

**Format: Rate Ratio (RR) [95% CI]

Discussion

This study provides further evidence that Native Hawaiians, Other Pacific Islanders, and Filipinos have significantly lower medication adherence rates compared to Caucasians, Chinese, and Japanese. Overall, average medication adherence for any race or ethnicity never exceeded 67.3%. Medication adherence has been cited as a major public health issue, especially for patients with chronic health problems.²⁶ Studies have shown a higher incidence of diabetes in lower socioeconomic groups, which could be related to lower medication adherence.¹⁴ Medication nonadherence is multifactorial and is related to an individual's socioeconomic status, as well as other environmental factors such as living area, education, and livelihood. Patients may forget to take their medication because they lead busy lives. In addition, some patients are not well educated about the risks associated with low medication adherence, so they do not take their medications. For several years, cholesterol medications were portrayed to have adverse side effects by the media, resulting in public wariness over statin drugs. This could account for the low rates of cholesterol lowering medication adherence in comparison to anti-hypertensive and anti-diabetic medication adherence.

Several studies have shown that decreased adherence can be associated with an increase in adverse events, which can lead to higher hospitalization rates, and therefore higher overall health-care expenditures.¹⁷⁻²⁰ Thus, we hypothesized that there would be a negative correlation between medication adherence and total health care costs. However, the results of this study showed that after controlling for demographic factors, Caucasians had the highest median total health care expenditures, despite this group having one of the highest medication adherence rates in the races/ethnicities studied. Filipinos had the lowest median total health care expenditures despite having the lowest medication adherence rates, along with Other Pacific Islanders.

Future studies are needed to identify other factors that may explain these ethnic disparities in total health care costs. These other factors may include variables such as quality of life or socioeconomic status.²⁷ For example, individuals in high socioeconomic groups are likely to have access to the most expensive insurance plans and are most likely to see their doctors regularly and pick up prescribed medication. In contrast, individuals in low socioeconomic groups may not go to the doctor regularly because they cannot afford it, and some may not pick up their medication because they do not live close to a pharmacy. Previous studies have shown that Native Hawaiians have high preventable hospitalization costs compared to Caucasians and Asian Americans.²⁸ These preventable costs are the result of Native Hawaiians, on average, visiting the doctor less regularly than other races/ethnicities, resulting in an increased chance of adverse health outcomes and hospitalization. Future studies are also needed to examine the impact of medication adherence on other important outcomes, including health-related quality of life.

This study had several limitations. It is a descriptive study with data taken from one insurance company in Hawai'i. Analyzing data from several different insurance companies would give a better description of the state's population. Medication adherence was measured through administrative claims data, with the assumption that individuals took the medications they picked up at the pharmacy. It is possible that individuals did not take these medications. This study also did not take into account free medication samples given out by physicians, the use of prescription drug coupons, or the impact of various medication adherence strategies employed by individuals, health care providers, or pharmacies.²⁹⁻³⁰ In addition, there was ambiguity in compiling the number of Emergency Department (ED) and hospital visits for each race/ethnicity. If a patient visited the ED and was discharged the same day, the visit was counted as an ED visit. However, if the patient visited the ED and was subsequently admitted into the hospital, the visit was counted only as a hospital visit. This method of data compilation could explain the very high Other Pacific Islander hospitalization rate compared to the low ED visit rate. It is possible that many of these hospitalizations were patients that initially presented in the ED and were later admitted into the hospital. Diabetes prevalence may have been underestimated for Native Hawaiians and Other Pacific Islanders because these groups are less likely to visit the doctor and are therefore less likely to be screened for diabetes. There is also the issue of timing. We examined health care costs in the same year as we measured medication adherence. It may be there is a lag in the negative effect of nonadherence, in that patients have higher health care costs a few years after they have low adherence. These higher costs would not have been captured in our study.

Conclusions

This study demonstrated racial and ethnic disparities in medication adherence and total health care expenditures. Filipinos, Native Hawaiians, and Other Pacific Islanders had significantly lower medication adherence than Caucasians, Japanese, and Chinese. Interestingly, Filipinos, Chinese, and Japanese had significantly lower total health care costs than Caucasians, Native Hawaiians, and Other Pacific Islanders. Differences in total health care expenditures persisted after controlling for medication adherence and other demographic factors. Future studies are needed to better understand the relationship between medication adherence and total health care expenditures. Given that total health care expenditures are not a definite indicator of quality of care or health, further research is needed to determine other influencing factors on total costs.

Conflict of Interest

None of the authors identify any conflict of interest.

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