Characteristics of Patients with Type 2 Diabetes Mellitus in Two Rural, Medically Underserved Communities

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Abstract

In the state of Hawai'i, Native Hawaiians and Filipinos suffer from increased disparities, compared to other groups, in diabetes prevalence and adverse health outcomes that are exacerbated by challenges to health care access among rural communities. To address the limited literature describing rural, underserved patients with diabetes in Hawai'i, this paper aims to characterize two rural communities that are located on Moloka'i and Lana'i in federally-designated medically underserved areas and that are served by a single Native Hawaiian health care system entitled Na Pu'uwai. Descriptive analyses examining associations between variables were performed using the baseline demographic information, clinical measures, and questionnaire responses collected from 40 adult study participants with diabetes. The data revealed that the study participants had a high prevalence of insulin use (60%); a HbA_{1c} level greater than or equal to 9% (55%); a high-fat diet (73%); and comorbidities, including hyperlipidemia (85%), hypertension (83%), and obesity (70%). Furthermore, among the participants, the mean SF-12v2™ General Health Perceptions Score was significantly lower for participants with uncontrolled diabetes compared to those with controlled diabetes (P= .02); however, this association was not statistically significant in the multivariable regression model that adjusted for age and number of diabetes medications. Based on these results, the participants appear to belong to a high-risk group with a complicated manifestation of diabetes. This study adds to the growing body of literature demonstrating disparities in diabetes among rural, minority, and underserved communities, highlighting the need for further investigation, development, and implementation of strategies for reaching these vulnerable populations.

Keywords

Adult; Diabetes Mellitus, Type 2, Diabetes Epidemiology, Hawai'i, Health Status Disparities, Healthcare Disparities, Minority Health, Rural Health

Introduction

Currently the fifth leading cause of death in Hawai'i, diabetes represents a significant burden for the state's people, affecting 8.3% of the Hawai'i adult population in 2010 and accounting for $1 billion in costs to the state in 2006.[1-4] Among the five largest ethnic groups of Hawai'i, diabetes disproportionately impacts Native Hawaiians and Filipinos. Compared to whites in Hawai'i, Native Hawaiians and Filipinos not only are on average 5-8 years of age younger at the time of diabetes diagnosis, but also have a 3-4 fold higher prevalence of diabetes.[2,5] Between 2004 and 2006, Native Hawaiians suffered from the highest rate of death from diabetes at 29.6 per 100,000, followed by 20.6 per 100,000 in Filipinos, 12.4 per 100,000 in Japanese, and 10.3 per 100,000 in Whites.[2]

The health disparities suffered by Native Hawaiians and Filipinos are further exacerbated when these racial/ethnic populations reside in rural communities, where health care access remains a challenge.[6,7] In fact, one-third of Hawai'i's state population resides in rural communities, in contrast to only 17% of the US population.[8,9] Compared to Honolulu County, Hawai'i's rural counties have more diabetic patients per medical specialist.[6,10,11] Rural residents are particularly vulnerable to developing serious and deadly diabetes-related complications due to limited access to non-urgent preventive care that is known to ameliorate the development of diabetic microvascular and macrovascular complications; this type of care includes diabetes self-management education, retinal screening, and cardiovascular risk management.[2] Ultimately, these challenges may result in a population that is less healthy overall and that may require higher tertiary care services at a higher cost to the health care system.[7,12] While diabetes prevalence is comparable among the counties of Hawai'i, issues in rural health could potentially explain the disparities in diabetes mortality rates by county. For example, in 2009, Maui County (includes the islands of Maui, Lana'i, and Moloka'i) and Kaua'i County suffered from higher rates of death due to diabetes (33.0 per 100,000 and 34.1 per 100,000 respectively) than Honolulu County (21.9 per 100,000).[1,2] To address issues related to diabetes medical management in rural Hawai'i, we undertook a quasi-experimental pilot study to examine the effectiveness of using telemedicine technology to provide diabetes specialty care in two remote communities on Lana'i and Moloka'i islands. The pilot study, entitled Pūlama Pau 'Ole I Ka Mimikō (Continually Taking Care of People with Diabetes), enrolled volunteers through the community-based organization, the Na Pu'uwai Health Care System that services both Lana'i and Moloka'i islands.

Although diabetes prevalence rates in the rural communities of Hawai'i have been reported in the literature, characterization of the diabetic patients living in these areas remains limited.[5,13,14] A better understanding of the health status and needs of these patients would be valuable for tailoring diabetes interventions and treatments to more effectively care for the rural, underserved populations of Hawai'i. To address this gap in knowledge, this paper aims to use patient baseline clinical measures and questionnaire responses to characterize a predominantly Native Hawaiian and Filipino, diabetic, and clinic-based population residing in two rural neighbor islands of Hawai'i.

Methods

Study Design

This paper analyzes the baseline characteristics collected from participants who enrolled in the Pūlama Pau 'Ole I Ka Mimikō study (aka, the Pūlama Study). The goal of this 6-month pilot study was to test a culturally competent chronic disease management program using telemedicine technologies (ie, video-teleconferencing) compared with usual care in type 2 diabetics. The Pūlama study was conducted on Moloka'i and Lana'i, which are two islands in federally-designated medically underserved areas with large numbers of Native Hawaiians and

Filipinos.[7] Both communities are served by the Na Pu'uwai Native Hawaiian Health Care System. Patients were recruited at Na Pu'uwai's Moloka'i and Lana'i clinical services programs, which routinely provide outpatient care services and community outreach health screenings in both rural communities. Recruitment was conducted via flyers, education outreach programs, and clinic staff. Approval was received from the University of Hawai'i Institutional Review Board prior to the start of any research activities.

Eligibility and Enrollment

A total of 113 individuals were contacted and screened for eligibility. A total of 40 people with diabetes met all eligibility criteria and agreed to participate. To be eligible, participants had to be age 18 years or older, have a diagnosis of type 2 diabetes, have a Hemoglobin A_{1c} (HbA_{1c}) level of $\geq$7.5% in the month prior to enrollment, be taking at least one anti-diabetic medication, and be residing on Moloka'i or Lana'i. The enrollment cutoff point of HbA_{1c} level of 7.5% or higher was selected to ensure that all potential participants who qualified to enroll would benefit from having an HbA_{1c} of <7%, the American Diabetes Association goal for HbA_{1c} levels.[15]

Individuals were excluded if they had any major medical (eg, hemodialysis, pregnancy, etc.) or psychiatric disorders that would prevent full participation (ie, non-adherence due to conflicting medical recommendations or psychiatric problems) in the study as determined by the study protocol. After giving written informed consent, participants underwent a baseline assessment according to study protocol.

Data Collection

Demographic factors including date of birth, sex, education, marital status, ethnicity, and smoking status were collected via a patient questionnaire. At baseline, participants were assessed for height, weight, and blood pressure. The participant's HbA_{1c}, fasting glucose, and lipid profile results were abstracted from laboratory tests, which were conducted within one month of study enrollment. Information on past medical history and medications were obtained with a questionnaire and/or from the participant's medical record.

Participants also completed a collection of surveys that were administered by the study nurse or self-administered. The 10-item short version of the Center for Epidemiologic Studies Depression Scale (CES-D) assessed self-reported depressive symptoms. Higher scores indicate more depressive symptoms and a score of 10 or greater signifies self-reported evidence of depression.[16,17] The Short Form-12v2™ Health Survey (SF-12v2™) was administered to measure health-related quality of life, and the study focused on the General Health Perceptions sub-scale, which is based on a single question asking patients to rate their general health. The SF-12v2™ uses a norm-based scoring method based on the 1998 general US population having a mean of 50 ± 10, with higher scores indicating a better health-related quality of life.[18] The proportion of fat intake in each participant's diet was determined using the Fat Factor Summary Score generated by the Eating Habits Questionnaire, which was adapted from the Eating and Exercise Patterns (EEPs) Questionnaire. Higher scores indicate greater fat intake and a Fat Factor Summary Score of greater than 2.5 predicts fat intake at greater than 30% of total calories.[19] The participants' level of physical activity was assessed through an adapted version of the Brief Physical Activity Questionnaire, which addresses the frequency of the participants' vigorous and moderate intensity activities. The range of possible Physical Intensity Scores is 1 to 5 with lower scores indicating greater intensity.[20] Finally, the Patient Assessment of Care for Chronic Conditions (PACIC) was used to evaluate how closely the participants' care aligned with the Chronic Care Model, which supports patient-centered and collaborative care. The PACIC produces a summary score based on sub-scales measuring patient activation, delivery system design and decision support, goal setting, problem-solving and contextual counseling, and follow-up and coordination. The PACIC Summary Score ranges from 1 to 5 with higher scores indicating a higher quality of care.[21]

Statistical Methods

Initial analyses examined the questionnaire responses and physiological measures descriptively. Continuous variables were summarized with means and standard deviations both for individual variables and within categories such as ethnic groups. Means of questionnaire responses comparing patients with controlled to uncontrolled diabetes were analyzed using t-tests. For the analyses, an HbA_{1c} level of 9% or higher was chosen as an indicator of poor diabetes control, a cutoff employed in the National Committee on Quality Assurance's Healthcare Effectiveness Data and Information Set (HEDIS).[22] Categorical variables were summarized using counts and percentages. Associations between categorical variables were examined using the Cochran-Mantel-Haenszel chi-square test for assessing group differences in outcomes having ordered categories, and using logistic regression. Exact logistic regression was employed when the number of outcomes within predictor categories was small. Results of the regression models are summarized as odds ratios with 95% confidence intervals.

Results

Participant Characteristics

A total of 40 diabetic patients (16 women and 24 men) with suboptimal glycemic control were enrolled with a mean age of 58 years and an age range of 24 to 88 years (Table 1). Most patients were married (80%) and had attended some college or had obtained a college degree (70%). About half had smoked in their lifetime. The majority identified ethnically as either Native Hawaiian (58%) or Filipino (25%). Nearly three-fourths of participants resided on the island of Moloka'i and the remainder resided on the island of Lana'i.

Table 2 and Table 3 report the participants' mean baseline clinical measures and questionnaire results respectively. The majority of participants had a history of hypertension (83%) and hyperlipidemia (85%), and almost a third had a history

Table 1. Demographic Characteristics of Patients with Type 2 Diabetes Mellitus in Two Rural, Medically Underserved Communities in Hawai'i (N = 40)

Demographic Characteristic	Pulama Study Participants n (%)[a] or Mean ± SD
Age at enrollment (years)	58 ± 13
Women	16 (40)
Marital status	
Married	32 (80)
Not married[b]	8 (20)
Education	
High school or less	12 (30)
Some college or college graduate	28 (70)
Race/Ethnicity	
Native Hawaiian	23 (58)
Filipino	10 (25)
Other[c]	7 (18)
Residence	
Moloka'i	29 (73)
Lana'i	11 (28)
Smoking status	
Never smoked	18 (45)
Current or former smoker	22 (55)

[a]Some percentages do not add up to 100% due to rounding
[b]"Not married" includes never married, divorced or separated, and widowed
[c]"Other" includes White (n = 4), Japanese (n = 2), and Samoan (n = 1)

Table 2. Clinical Characteristics of Patients with Type 2 Diabetes Mellitus in Two Rural, Medically Underserved Communities in Hawai'i (N = 40)

Clinical Characteristic	Pulama Study Participants n (%) or Mean ± SD
Clinical/Laboratory Assessments	
Body mass index (kg/m^2)	33 ± 9
Body mass index ≥ 30	28 (70)
Systolic blood pressure (mmHg)	131 ± 20
Diastolic blood pressure (mmHg)	76 ± 13
Hemoglobin A_{1c} (%)	9.6 ± 1.6
Hemoglobin A_{1c} ≥ 9%	22 (55)
Fasting glucose (mg/dL)	182 ± 62
Total cholesterol (mg/dL)	167 ± 36
Triglycerides (mg/dL)	207 ± 206
HDL-cholesterol (mg/dL)	
Women	45 ± 10
Men	42 ± 13
Calculated LDL-cholesterol (mg/dL) (n = 34)[a]	87 ± 23
History of:	
Hypertension	33 (83)
Hyperlipidemia	34 (85)
Gout	5 (13)
Heart disease	12 (30)
Diabetes Medications	
Biguanide	24 (60)
Sulfonylurea	26 (65)
Thiazolidenedione	7 (18)
DPP4 Inhibitor	12 (30)
Insulin	24 (60)
Exenatide (Byetta)	1 (3)
Number of diabetes medications	
One	9 (23)
Two	14 (35)
Three	11 (28)
Four	6 (15)

[a]Unable to calculate LDL values for some participants (n = 6) due to their high levels of triglycerides.

of heart disease. About three-fourths were taking at least two diabetes medications and 60% were taking insulin (Table 2). Most participants (90%) had an SF-12v2™ General Health Perceptions score below the average score of the general US population, and 30% of participants scored below the average of those with diabetes within the general US population.[18] Based on the CES-D and Eating Habits Questionnaire, 38% of the participants were depressed and nearly three-fourths had a diet with fat constituting over a third of their total caloric intake (Table 3).

Factors Associated with Poor Glycemic Control

Fifty-five percent of the study participants had an HbA_{1c} level of at least 9% (Table 2). Logistic regression analysis revealed that participants with controlled diabetes (HbA_{1c} < 9%) did not differ significantly from participants with uncontrolled diabetes (HbA_{1c} ≥ 9%) in terms of their age, sex, ethnicity, number of diabetes medications, number of comorbidities, or odds of having a SF-12v2™ General Health Perceptions Score below 50 (Table 4). However, the mean SF-12v2™ General Health Perceptions Score was 8 units lower for participants with uncontrolled diabetes compared to those with controlled diabetes (P = .02). When examined in a multivariable regression model, poor glycemic control was not significantly associated with increasing age, the number of diabetes medications, or a better health-related quality of life (Table 5).

Discussion

The predominantly Native Hawaiian and Filipino, rural, and clinic-based participants of the Pūlama study appeared to be less healthy than other diabetic patients surveyed nationally. Over half of the study participants suffered from uncontrolled diabetes. Poor glycemic control has also been observed in other rural communities in Hawai'i. For example, a study conducted at the Waianae Coast Comprehensive Health Center (WCCHC) which serves a medically underserved, predominantly Native Hawaiian community on O'ahu, also found more than 38% (n = 52) of their diabetic patients had poorly controlled diabetes (HbA_{1c} >10%), while 25% of their patients were found to have a HbA_{1c} of 7.5% or less.[7,23] Compared to the general US

Table 3. Assessment of Questionnaire Results in Patients with Type 2 Diabetes Mellitus in Two Rural, Medically Underserved Communities in Hawai'i (N = 40)

Questionnaire	Pulama Study Participants n (%) or Mean ± SD
Center for Epidemiologic Studies Depression Scale (CES-D)	
CES-D Score	7.6 ± 5.2
Depressed	15 (38)
SF-12v2™ Health Survey	
General Health Perceptions Score	40 ± 11
Participants scoring below average of general US population (Score < 50)	36 (90)
Participants scoring below average of US diabetic population (Score < 41)	12 (30)
Eating Habits Questionnaire[a]	
Fat Factor Summary Score	2.7 ± 0.4
Fat Intake at > 30% of Total Calories	19 (73)
Brief Physical Activity Questionnaire	
Physical Intensity Score	3.4 ± 1.1
Patient Assessment of Care for Chronic Conditions (PACIC)	
PACIC Summary Score	3.5 ± 0.9

[a]For the Eating Habits Questionnaire, n = 26.

Table 4. Univariate Analysis of Factors Associated with Poor Glycemic Control (HbA1c ≥ 9%) in Patients with Type 2 Diabetes Mellitus in Two Rural, Medically Underserved Communities in Hawai'i (N = 40)

Characteristic	Unadjusted Odds Ratio (95% CI)	P-value
Age		
24-52 years	1.0 Referent	
53-64 years	1.14 (.25-5.22)	.86
65-88 years	1.00 (.21-4.67)	1.00
Sex		
Women	1.0 Referent	
Men	.92 (.26-3.28)	.90
Ethnicity		
Other	1.0 Referent	
Native Hawaiian	1.73 (.31-9.57)	.53
Filipino	2.00 (.28-14.20)	.49
Number of diabetes medications		
1-2	1.0 Referent	
≥ 3	.87 (.25-3.05)	.82
Number of co-morbidities[a]		
0-2	1.0 Referent	
≥ 3	3.17 (.66-15.11)	.15
SF-12v2™ Health Survey General Health Perceptions Score		
> 50	1.0 Referent	
≤ 50	7.60 (1.2-Infinity)	.07

[a]Comorbidities assessed in this study include only hypertension, hyperlipidemia, gout, and heart disease.

Table 5. Multivariable Association of Poor Glycemic Control with Selected Risk Factors in Patients with Type 2 Diabetes Mellitus in Two Rural, Medically Underserved Communities in Hawai'i (N = 40)

	Adjusted Odds Ratio[a]	95% Confidence Interval
Age	1.01	0.95-1.07
Number of Diabetes Medications	1.12	0.57-2.19
Better Health-Related Quality of Life[b]	0.92	0.85-1.00

[a]Age, number of diabetes medications, and better health-related quality of life were included in the model, and each was adjusted for the other two.
[b]SF-12v2™ General Health Perceptions Score as a continuous variable.

diabetic population, the Pūlama study participants had a higher prevalence of insulin use, comorbidities (heart disease, hypertension, hyperlipidemia, and obesity), and fat intake exceeding the recommendations for a reduced fat diet, suggesting that this clinic-based population is at increased risk for adverse clinical outcomes such as microvascular and macrovascular complications.[24-27] Additionally, nearly one-third of participants had an average rating for overall health that was lower than the average score of diabetic individuals who participated in the 1998 National Survey of Functional Health Status.[18]

Compared to participants with controlled diabetes, those with uncontrolled diabetes had a statistically significant lower mean SF-12v2™ Health Survey General Health Perceptions Score; however, this association was not statistically significant in the multivariable regression model that adjusted for age and number of diabetes medications. One study conducted with 150 patients seen at four diabetes clinics in Malaysia did find statistically significant differences between patients with controlled and poorly controlled diabetes in their mean General Health Perceptions Score after controlling for age and diabetes duration.[28] However, this study differed from the Pūlama study in its use of the longer SF-36 Health Survey and less stringent criteria for poorly controlled diabetes. One possible explanation of the observed relationship between glycemic control and self-reported health status is that those with worse HbA_{1c} values may suffer from greater complications and symptoms, and thus be more likely give a lower rating of their overall health. Nevertheless, the literature examining the relationship between glycemic control and health-related quality of life remains inconsistent.[28-30] Furthermore, it is difficult to draw generalizable conclusions from the Pūlama study, since the data was obtained from a single time point as well as a small sample size, and there was a lack of control for confounders.

Other studies identifying predictors of glycemic control similarly have not found statistically significant differences between controlled and uncontrolled diabetic patients in terms of

gender, history of hypertension, or history of dyslipidemia.[31-35] Some predictors of higher HbA_{1c} levels in diabetic patients that have been documented include increased waist circumference, poor adherence to diabetes self-care management behaviors, low income, lack of insurance, and increased distress about diabetes, none of which were examined in the Pūlama study.[31,33,35] Moreover, medication type, diabetes duration, and age have been shown to be associated with poor glycemic control in some studies, although the evidence is contradictory.[31-37] These studies used different cut-off points for uncontrolled diabetes ($HbA_{1c} \geq 7\%$, $\geq 8\%$, $>9.2\%$), which may affect comparisons with the Pūlama study ($HbA_{1c} \geq 9\%$).

Study Limitations

This paper is descriptive in nature and possesses multiple limitations in addition to those detailed above. Because of its small sample size (N = 40), this study has low statistical power and confidence intervals that may be difficult to interpret. Furthermore, conclusions from this study may not be generalizable to other rural communities in Hawai'i, and because of the selection criteria, the study may not have captured all the variability that exists within the communities from which the participants were sampled. Because the data was collected from a single point in time, temporality and causal relationships cannot be established. The participants were also sampled from clinic-based populations associated with Na Pu'uwai and by definition were required to have a HbA_{1c} value of $\geq 7.5\%$, so they are more likely to be sicker and have more complicated diabetes management (ie, insulin-requiring diabetes) compared to the general diabetic population. While some information was obtained from patient medical records, most data was collected via participant self-report, which could have introduced recall bias or social desirability bias. The survey instrument used to measure fat intake (Eating Habits Questionnaire) was introduced late into the study, so the measure was only available for 65% of the participants, which may have impacted the results of that variable considering the small size of the study.

Implications

This paper describes some of the characteristics of diabetic patients living in two isolated, medically underserved regions of Hawai'i. This clinic population represents a high-risk group of patients with complicated diabetes mellitus, as reflected by the high prevalence of insulin use, poor glycemic control, a high-fat diet, and co-existing morbidities. Though the study included a relatively small select group of patients, these results highlight the burden of poorly controlled diabetes in remote locations that often have limited access to specialty care to address multi-complex management needs of patients with diabetes. Patients in these remote locations with poorly controlled diabetes also tended to have lower ratings of their overall health with about one-third of participants scoring lower than diabetic individuals surveyed in the 1998 National Survey of Functional Health Status.

With a high prevalence of uncontrolled diabetes, Native Hawaiian and Filipino diabetic patients in these rural communities of Hawai'i may potentially have increased vulnerability to complications, such as heart disease, stroke, vision loss, kidney disease, nervous system damage, and amputations.[38] These health issues may be compounded when communities face problems of reduced access to health care resources. Analysis of the 2009 BRFSS revealed that compared to non-rural diabetic adults, rural diabetic adults, and especially non-Caucasian rural diabetic adults, were less likely to receive adequate diabetes care, which included engaging in self-management behaviors; receiving diabetes education; and having one cholesterol check-up, at least two HbA_{1c} check-ups, at least two feet check-ups, and a dilated eye exam in the past 12 months.[39]

This study adds to the growing body of literature demonstrating disparities in the burden of diabetes in rural, minority, and underserved communities, highlighting the necessity for further investigation, development, and implementation of strategies for reaching these vulnerable populations.[40-42] The results of this small descriptive study suggest that further research on the factors that could improve diabetes control and influence morbidity and mortality due to complications of diabetes in these high risk populations is needed. Research examining the issue of access to specialty care (endocrinology, ophthalmology, etc.) and other health providers (Certified Diabetes Educators, dieticians, etc.) could also identify opportunities to improve diabetes management within these communities. A component of the Pūlama study intervention includes the use of telemedicine technologies to provide enhanced diabetes management (including specialty care) to diabetic patients on the island of Moloka'i, which is a potentially promising strategy for reaching these small, remote/rural communities with complex diabetes related health problems.[40,43,44] Finally, due to the high prevalence of self-reported depression (38%) among the participants, developing interventions designed to integrate behavioral health programs that address depression within the diabetic patient community could benefit the rural Native Hawaiian and Filipino communities examined here.

Conflict of Interest

None of the authors identify any conflict of interest.

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