

PREVALENCE OF OCULAR AND SYSTEMIC DISEASE IN THE NATIVE  
POPULATION IN PAWNEE, OK

by

Brian Sklapsky

And

Benjamin Dietrich

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Benjamin Dietrich

Has been approved

May, 2013

ACCEPTED:

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Faculty Course Supervisor

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## ABSTRACT

*Background:* This research study evaluates the systemic and ocular manifestations of the general population in Pawnee, Oklahoma. Many systemic diseases including diabetes and hypertension have a higher incidence in this population compared to the general public. High levels of astigmatism, greater than two diopters, also have a higher incidence in Native Americans when compared to the general population. *Methods:* Information from the patient history was collected from 629 patients ranging in age of 21 to 94. Collection occurred while on rotation at the Pawnee Indian Health Service in Pawnee, OK in December 2012. Each patient underwent a comprehensive eye examination including dilation. *Results:* A cross-sectional study was performed from the information received in the patient history and during fundus examination. The prevalence of systemic diseases such as diabetes and hypertension were 38.8% and 55.5%. High levels of astigmatism, greater than or equal to two diopters, was 12.4%. *Conclusions:* The Native American population in Pawnee, OK has a high incidence of diabetes, diabetic retinopathy, hypertension, and high levels of astigmatism. These rates are higher than the average norms in the United States. Preventative programs should be established in this community to increase the health and awareness of this population.

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## Introduction

The United States currently has an epidemic in relation to systemic disease. Diabetes mellitus type II and hypertension are two of the most prevalent diseases seen. Recent data shows 11.3%<sup>1</sup> of adults have diabetes mellitus and 32.4% have hypertension.<sup>2</sup> Ocular manifestations occur in 13.3% of those with diabetes in the United States.<sup>1</sup>

## Diabetes:

According to the American Diabetes Association, type II diabetes, heart disease, and stroke can be affected by many things, including age, family history, and race. African Americans, Native Hawaiians, Asian Americans, Pacific Islanders, and American Indians all have a higher risk of developing one of these diseases because these populations tend to be overweight or have a higher blood pressure.<sup>3</sup> These races also have a higher risk of any complications associated with diabetes.<sup>4</sup>

Diabetes affects 25.6 million people or 11.3% of the population in the United States alone and is the seventh leading cause of death in the United States. Indian Health Services in 2009 indicated that 14.2% of American Indians treated in clinics had a diagnosis of diabetes, but this number varied by region. The rate of new cases in children aged 10-19 among American Indians was higher for type II than type I.<sup>4</sup>

Based on A1c levels, 35% of adults 20 years of age or older of the total population were considered pre-diabetic; this number jumps to 50% in adults over 65. Only 20% of American Indians aged 15 or older from 2001-2004 were considered to have pre-diabetes, based on the A1c alone. The higher the A1c number, the increased chance of developing heart disease, stroke, or diabetes.<sup>4</sup>



In the United States, diabetic retinopathy is the leading cause of new cases of blindness.<sup>4</sup> Lee et al found a high prevalence of diabetic retinopathy (20.1%) in American Indians in Oklahoma.<sup>5</sup>

#### Hypertension:

The terms hypertension and high blood pressure are often used interchangeably. According to the CDC, 33% of Americans aged 20 or older, or 68 million Americans, were considered to have hypertension.<sup>6</sup> In comparison, the Strong Heart study was a 13 year study of 13 American Indian tribes/communities throughout the United States. Of the 4,549 patients studied, only 2,629 were used since the others at baseline already had hypertension or cardiovascular disease. The study concluded that the prevalence of pre-hypertension in this population was high in non-diabetic patients (48.2%) and even higher (59.4%) in the non-hypertensive diabetics.<sup>7</sup> It is thought that high blood pressure costs the United States approximately \$93.5 billion dollars annually on medications, services, and missed work days.<sup>6</sup>

#### High Astigmatism:

High levels of uncorrected astigmatism can be detrimental to the visual acuity of an individual. The incidence of high astigmatism, greater than two diopters, has been shown to be relatively low in the United States at 6.8%.<sup>8</sup> These numbers are believed to be much higher in small ethnic groups. Harvey, Dobson, and Miller found a 42% prevalence of astigmatism greater than -1.00 diopter in either eye, which resulted in a visual acuity worse than 20/40 in children from the Tohono O'odham tribe.<sup>9</sup> What was even more alarming was that many of these children did not own or wear any sort of vision correction. Harvey et al continued this work and found a prevalence of

astigmatism of greater than -2.00 diopters at infancy was 30%, dipping to 14% at age 1 to less than 2, and 23-29% at ages 2 to 7.<sup>10</sup>

This study examined Native Americans in Pawnee, Oklahoma. A retrospective study was performed to assess the systemic and ocular disease prevalence. This study was intended to compare the rate of systemic and ocular disease to national averages hypothesizing the rates to be much higher in Pawnee, Oklahoma.

#### Methods

All subjects of this study were patients at Pawnee Indian Health Services in Pawnee, Oklahoma. This facility is a federally funded healthcare provider of American Indians and Alaskan Natives.<sup>11</sup> In order to be accepted as a patient, all candidates must prove ancestry or by enrolling as a member of a federally recognized Tribe.<sup>12</sup>

This retrospective medical review was performed among all patients seen between January 2, 2012 and July 31, 2012. During this time period, 629 full exams were performed on patients over the age of 21. A full exam included a comprehensive ocular health exam with a view of the posterior pole, either dilated or undilated. Patients under the age of 21 or who were seen as part of a follow-up examination, office visit, or seen by the retinal specialist for treatment or evaluation were not included in the study.

#### Results

Subjects were grouped based on age, ranging from 21-29 up to 90-99. Of the 629 comprehensive examinations, 355 were female and 274 were male.

**Diabetes:**

Of the 355 females examined, 143 were diabetic (40.3%). Of the 274 males examined, 101 were diabetic (36.9%). Total number of diabetic patients was 244 or 38.8% (see Table 1 and Graph 1).

Female diabetics who were diagnosed with some form of diabetic retinopathy totaled 21 or 14.7% of all diabetic females. Male diabetics who were diagnosed with diabetic retinopathy totaled 21 or 20.8% of all diabetic males. Total number of diabetics (both male and female) who were diagnosed with diabetic retinopathy was 42 or 17.2% of all diabetic patients (see Tables 2).

**Table 1: Total Number of Subjects by Age Range, Diabetics, and Gender**

Age Range	N	Females	Males	Females with DM	% DM Females	Males with DM	% DM Males	Total Subjects with DM	Total % with DM
21-29	69	36	33	1	2.8	2	6.1	3	4.3
30-39	60	40	20	10	25.0	3	15.0	13	21.7
40-49	111	63	48	23	36.5	15	31.3	38	34.2
50-59	161	91	70	46	50.5	29	41.4	75	46.6
60-69	131	70	61	38	54.3	30	49.2	68	51.9
70-79	72	37	35	20	54.1	18	51.4	38	52.8
80-89	22	15	7	4	26.7	4	57.1	8	36.4
90-99	3	3	0	1	33.3	0	0.0	1	33.3
	629	355	274	143	40.3	101	36.9	244	38.8

Graph 1: Total Number of Females and Males with and without Diabetes based on Age

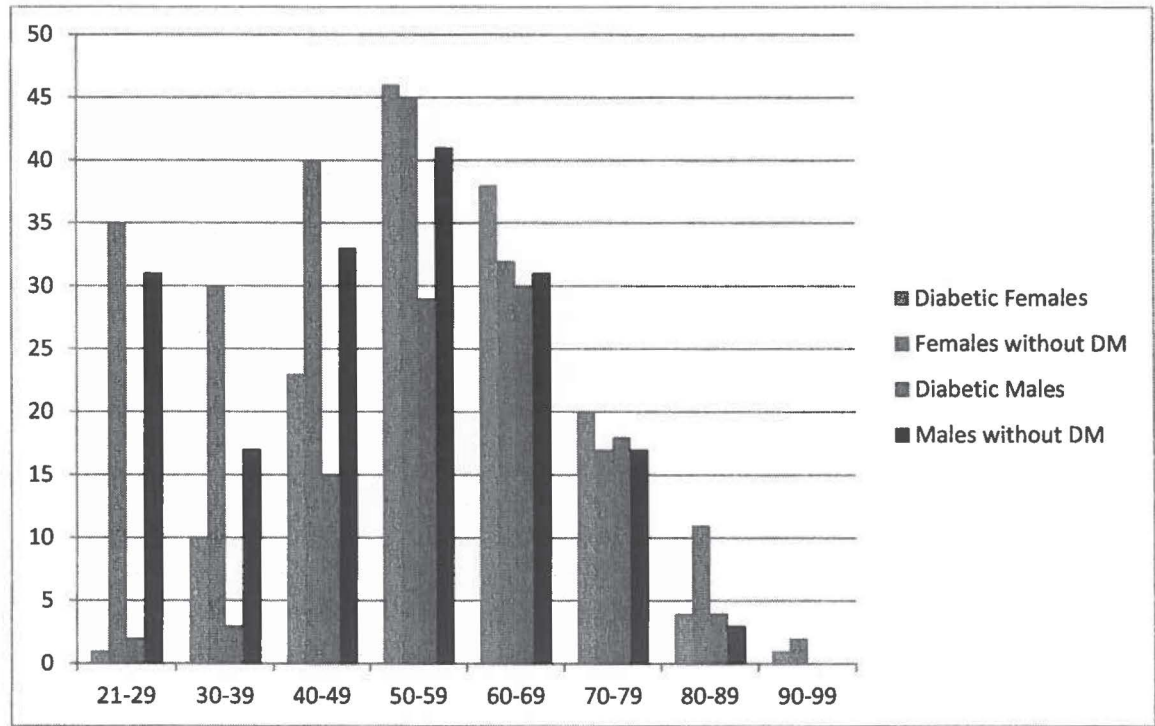
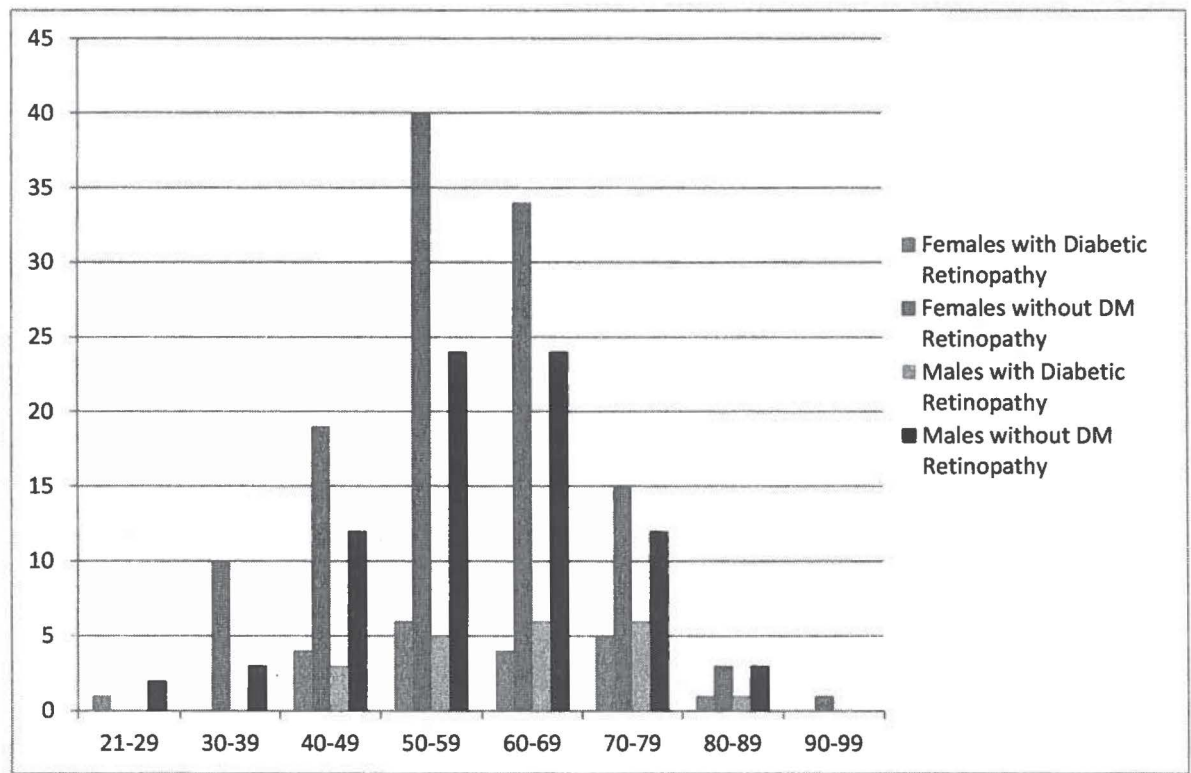


Table 2: Diabetic Retinopathy by Age and Gender

Age Range	Diabetic Females	Females with Diabetic Retinopathy	% DM females with retinopathy	Diabetic Males	Males with Diabetic Retinopathy	% DM males with retinopathy	Total Diabetics	Total Subjects with Retinopathy	Total % with Retinopathy
21-29	1	1	100.0	2	0	0.0	3	1	33.3
30-39	10	0	0.0	3	0	0.0	13	0	0.0
40-49	23	4	17.4	15	3	20.0	38	7	18.4
50-59	46	6	13.0	29	5	17.2	75	11	14.7
60-69	38	4	10.5	30	6	20.0	68	10	14.7
70-79	20	5	25.0	18	6	33.3	38	11	28.9
80-89	4	1	25.0	4	1	25.0	8	2	25.0
90-99	1	0	0.0	0	0	0.0	1	0	0.0
Total	143	21	14.7	101	21	20.8	244	42	17.2

Graph 2: Diabetic Males and Females With and Without Retinopathy



Hypertension:

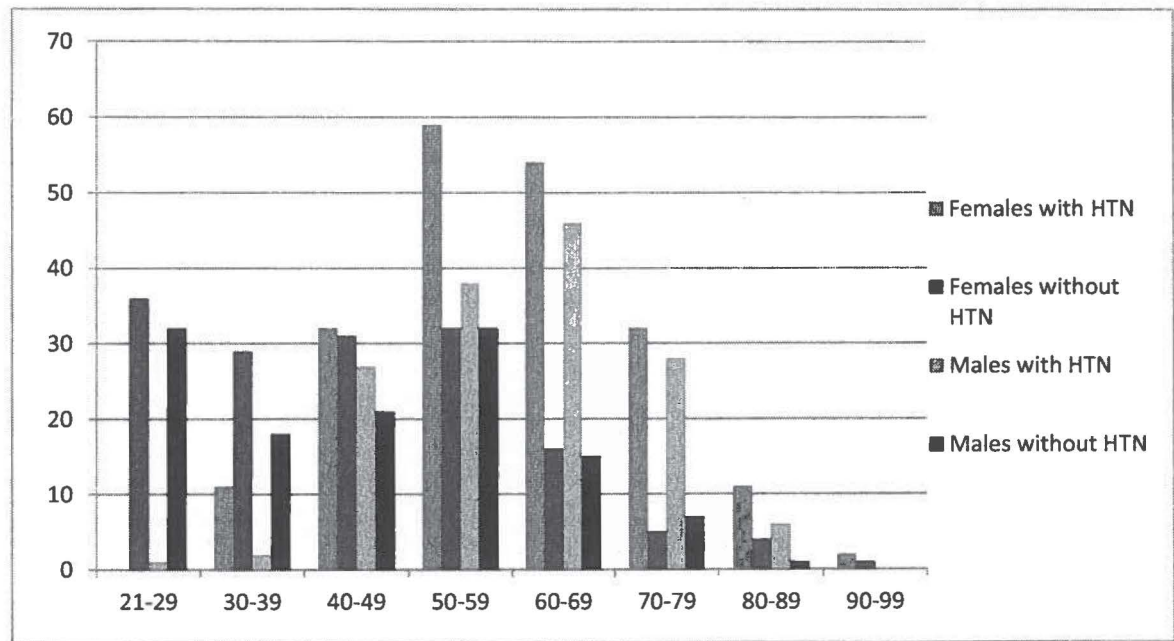
The number of female subjects with hypertension was 201, or 56.6% of all females. As the age of female subjects increased, the prevalence of females with hypertension increases until it peaks at age 70-79 where 86.5% of all women had hypertension.

The number of males with hypertension was 148, or 54.0% of all males. As the age of male subjects increased, the prevalence of males with hypertension also increases until it peaks at age 80-89 at 85.7%. The total number of patients with hypertension was 349, or 55.5% of all patients (see Table 3 and Graph 3).

Table 3: Males, Females, and Total Population with Hypertension

Age Range	N	Total Females	Females with HTN	% Females with HTN	Total Males	Males with HTN	% Males with HTN	Total Subjects with HTN	Total % with HTN
21-29	69	36	0	0.0	33	1	3.0	1	1.4
30-39	60	40	11	27.5	20	2	10.0	13	21.7
40-49	111	63	32	50.8	48	27	56.3	59	53.2
50-59	161	91	59	64.8	70	38	54.3	97	60.2
60-69	131	70	54	77.1	61	46	75.4	100	76.3
70-79	72	37	32	86.5	35	28	80.0	60	83.3
80-89	22	15	11	73.3	7	6	85.7	17	77.3
90-99	3	3	2	66.7	0	0	0.0	2	66.7
Total	629	355	201	56.6	274	148	54.0	349	55.5

Graph 3: Males and Females with and without Hypertension



**Astigmatism:**

Female eyes with no astigmatism made up 26.1% of all eyes, with peak prevalence at 45.8% at age 21-29. Astigmatism between -0.25 and -0.75 diopters were 36.6% in females with peak prevalence at 48.6% at age 60-69. Astigmatism between -1.00 and -1.75 diopters were 24.9% of all females with peak prevalence at 50.0% at age 70-79. Astigmatism -2.00 diopters and above were 12.4% of all females (see Table 4).

Male eyes with no astigmatism made up 29.2% of all male eyes, with peak prevalence at 39.6% at age 40-49. Astigmatism between -0.25 and -0.75 diopters were 30.8% in males with peak prevalence of 37.7% at age 60-69. Astigmatism between -1.00 and -1.75 diopters were 24.6% in males with peak prevalence of 42.9% at age 70-79. Astigmatism -2.00 diopters and above were 15.3% in males with peak prevalence of 31.8% at age 21-29 (see Table 5).

Total Astigmatism for both male and female eyes showed no astigmatism in 27.4% of total eyes with a peak prevalence of 31.7% at age 50-59. Astigmatism between -0.25 and -0.75 diopters were 34.1% of total eyes with peak prevalence of 43.5% at age 60-69. Astigmatism between -1.00 and -1.75 diopters were 24.8% of total eyes with peak prevalence of 46.5% at age 70-79. Astigmatism of -2.00 diopters and above was 13.7% (see Table 6).

Table 4: Amount of Astigmatism in Females by Age Range and Diopter Range

Age Range	# of Female eyes	# of eyes with no astigmatism	% with no astigmatism	# of eyes with -0.25 to -0.75 diopters	% with -0.25 to -0.75 diopters	# of eyes with -1.00 to -1.75 diopters	% with -1.00 to -1.75 diopters	# of eyes with -2.00 diopters and above	% with -2.00 diopters and greater
21-29	72	33	45.8	16	22.2	13	18.1	10	13.9
30-39	80	24	30.0	27	33.8	18	22.5	11	13.8
40-49	126	30	23.8	49	38.9	25	19.8	22	17.5
50-59	182	58	31.9	67	36.8	39	21.4	18	9.9
60-69	140	28	20.0	68	48.6	32	22.9	12	8.6
70-79	74	10	13.5	22	29.7	37	50.0	5	6.8
80-89	30	2	6.7	10	33.3	11	36.7	7	23.3
90-99	6	0	0.0	1	16.7	2	33.3	3	50.0
Total	710	185	26.1	260	36.6	177	24.9	88	12.4

Table 5: Amount of Astigmatism in Males by Age Range and Diopter Range

Age Range	# of Male eyes	# of eyes with no astigmatism	% with no astigmatism	# of eyes with -0.25 to -0.75 diopters	% with -0.25 to -0.75 diopters	# of eyes with -1.00 to -1.75 diopters	% with -1.00 to -1.75 diopters	# of eyes with -2.00 diopters and above	% with -2.00 diopters and greater
21-29	66	19	28.8	13	19.7	13	19.7	21	31.8
30-39	40	11	27.5	14	35.0	11	27.5	4	10.0
40-49	96	38	39.6	28	29.2	14	14.6	16	16.7
50-59	140	44	31.4	46	32.9	29	20.7	21	15.0
60-69	122	32	26.2	46	37.7	33	27.0	11	9.0
70-79	70	14	20.0	18	25.7	30	42.9	8	11.4
80-89	14	2	14.3	4	28.6	5	35.7	3	21.4
90-99	0	0	0.0	0	0.0	0	0.0	0	0.0
Total	548	160	29.2	169	30.8	135	24.6	84	15.3



Table 6: Amount of Astigmatism in Adults by Age Range and Diopter Range

Age Range	Total # of eyes	# of eyes with no astigmatism	% with no astigmatism	# of eyes with -0.25 to -0.75 diopters	% with -0.25 to -0.75 diopters	# of eyes with -1.00 to -1.75 diopters	% with -1.00 to -1.75 diopters	# of eyes with -2.00 diopters and above	% with -2.00 diopters and greater
21-29	138	52	37.7	29	21.0	26	18.8	31	22.5
30-39	120	35	29.2	41	34.2	29	24.2	15	12.5
40-49	222	68	30.6	77	34.7	39	17.6	38	17.1
50-59	322	102	31.7	113	35.1	68	21.1	39	12.1
60-69	262	60	22.9	114	43.5	65	24.8	23	8.8
70-79	144	24	16.7	40	27.8	67	46.5	13	9.0
80-89	44	4	9.1	14	31.8	16	36.4	10	22.7
90-99	6	0	0.0	1	16.7	2	33.3	3	50.0
Total	1258	345	27.4	429	34.1	312	24.8	172	13.7

### Discussion

Native Americans of Pawnee, Oklahoma have much higher rates of system and ocular disease compared to United States averages. The total incidence of diabetes mellitus type II at the Pawnee Eye Clinic was 38.8%, whereas the rest of the country was at 11.3%. The incidence of diabetes at all ages is higher in the Pawnee Native Americans compare to national averages (see table 7).<sup>13</sup> There was also an increase in ocular manifestations from diabetes, an increase up to 17.2% from the national average of 13.3%. This not only shows an increase in the prevalence of the disease, but also an increase in severity as the population ages (see table 8).<sup>14</sup> Hypertension also had a large increase in prevalence from an average of 32.4% for the national average going all the

way up to 55.5%. The Native American Indian averages separated by age were all higher than their corresponding national averages (See table 9).<sup>15</sup> Astigmatism greater than two diopters was almost double the national average of 6.8% at 12.4%. This is likely the trend throughout adulthood, but there is limited data of national averages of astigmatism throughout life.

Table 7: Incidence of Diabetes

Age Range	Pawnee	U.S. Average <sup>13</sup>
20-44	28.3%	3.7%
45-64	47.2%	13.7%
65 and older	48.9%	26.9%

Table 8: Incidence of Diabetic Retinopathy

Age Range	Pawnee	U.S. Average <sup>14</sup>
40-49	18.4%	2.3%
50-64	14.7%	5.6%
65-74	19.4%	8.9%
75 and older	28.5%	8.1%

Table 9: Incidence of Hypertension

Age Range	Pawnee	U.S. Average <sup>15</sup>
20-34	8.3%	5.3%
35-44	34.8%	17.4%
45-54	56.7%	33.3%
55-64	69.4%	49.6%
64-74	81.0%	61.7%
75 and older	80.7%	75.1%

These results show a large increase in disease and astigmatism in this small population, but there may be other factors influencing the data. This study was performed in a health service building which usually only sees sick patients. Therefore the numbers likely show a higher percentage of unhealthy patients because these are the

patients who need treatment. The patients without diabetes and normal blood pressure are not coming for eye exams. Indian Health Services goal is to have all diabetics in for a yearly eye exam. This likely increase the number of diabetic patients seen compared to those healthy patients who come every other year or never at all. Also there may be a social economic component. Wealthy Native Americans may be using other resources for their healthcare. This could skew the results by not including them into the study.

#### Conclusion

The actual disease prevalence found in this study is not likely to be as high as stated due to these flaws in the research. Even so, they are likely to be much higher than the national averages. More research must be done to show the full effects of disease prevalence in the Pawnee Native Americans. Preventative programs, including a greater awareness of the importance of diabetic dilated ocular examinations, should be established in this community to increase the health and awareness of this population.

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