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Hyperglycemia and type 2 diabetes among Filipino women in the Philippines, Hawaii, and San Diego

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Abstract

Background—Diabetes risk increases as immigrant populations adopt western lifestyles. We compared the prevalence of fasting hyperglycemia among Filipino women aged 40–79 years in the Philippines, Hawaii, and San Diego.

Methods—Data were obtained from the (1) Philippine National Nutrition Survey (1998), (2) Native Hawaiian Health Research Project (1997–2001), and (3) University of California San Diego Filipino Women's Health Study (1995–1999). Fasting glucose after an 8 h fast, blood pressure, and body mass index (BMI) were measured in all three regions; a 75 g oral glucose tolerance test was performed in San Diego and Hawaii.

Results—The proportion of Filipinas with BMI ≥ 30 kg/m^2 was higher in Hawaii (20%) compared to women in San Diego (9.3%) or the Philippines (5.2%, $p < 0.001$). Fasting hyperglycemia prevalence (fasting plasma glucose ≥ 126 mg/dl or fasting whole blood glucose ≥ 110 mg/dl) did not differ among Filipinas in the Philippines (11.8%), San Diego (14.1%), and Hawaii (14.7%, $p = 0.323$). Type 2 diabetes prevalence was similar among Filipinas in San Diego (31.6%) and Hawaii (24.9%, $p = 0.79$).

Conclusions—Despite regional differences in obesity, fasting hyperglycemia was similar among Filipinas in the Philippines, San Diego, and Hawaii and type 2 diabetes prevalence was similar among Filipinas in San Diego and Hawaii.

Keywords

Filipino; Type 2 diabetes; Hyperglycemia; Philippines; Hawaii; San Diego

1. Introduction

Ethnic disparities in type 2 diabetes prevalence in the United States (US) have been attributed to ethnic differences in adiposity [1–5]. Epidemiologic studies of immigrant populations have shown an increased risk of type 2 diabetes associated with the adoption of a western diet and

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lifestyle [5–9]. The colonial relationship between the US and the Philippines that began in 1898 resulted in waves of Filipino migration to the US. Immigrants from the Philippines comprise the second largest immigrant population in the US, following Mexicans [10]. Filipinos account for 15% of Hawaii's population and 1.2 million of California's population [11,12] yet data on diabetes prevalence among Filipinos are scarce [13–15]. Type 2 diabetes prevalence among 50–69-year-old women in San Diego, California was significantly higher among Filipino women (36%) compared to Caucasian women (9%) of similar age, education, and body size [15]. Type 2 diabetes prevalence was significantly higher among Filipinas at every tertile of visceral adipose tissue (by computed tomography) compared to Caucasian or African–American women [16]. The majority (99%) of San Diego Filipinas were immigrants, however, duration of immigration was not associated with diabetes risk. Further, body size of Filipinas with diabetes in the San Diego cohort was similar to that reported from the Philippines [17]. A comparison of type 2 diabetes prevalence among Filipinas in the Philippines and the US has not been reported, and could provide information useful for discerning heritable from behavioral factors associated with type 2 diabetes.

2. Objectives

The objectives of this investigation are to compare the age-adjusted prevalence of (1) fasting hyperglycemia among Filipinas aged 40–79 years in the Philippines, Hawaii, and San Diego and (2) type 2 diabetes among Filipinas in Hawaii and San Diego.

3. Materials and methods

3.1. Study population

Philippines (PH)—The 1998 National Nutrition Survey, a population-based study conducted by the Philippine Food and Nutrition Research Institute, the Department of Health, and the Hypertension, Diabetes and Lipid Study Group, was conducted to assess the prevalence of lifestyle related diseases including hypertension, hyperglycemia, and lipid abnormalities [18, 19]. Random sampling of men and women, aged ≥20 years was conducted by neighborhood in 13 of 15 regions of the archipelago.

Hawaii (HI)—The Native Hawaiian Health Research Project, a population-based, cross-sectional study to determine the association between cardiovascular risk factors, glucose intolerance, insulin resistance, and ethnicity, conducted a multi-ethnic study from 1997 to 2001 [1,20]. Participants included a comparison cohort of Filipinos, ≥18 years of age, who were recruited from a rural community (North Kohala) on the island of Hawaii, using census data for door-to-door sampling.

San Diego (SD)—The University of California San Diego (UCSD) Filipino Women's Health Study, measured the prevalence of several chronic diseases including osteoporosis, cardiovascular disease, hypertension, obesity, and diabetes between 1995 and 1999 [15]. Participants included volunteer, community-dwelling women, aged ≥40 years, and were recruited at churches, social functions, and festivals and with the help of Filipino organizations, local Filipino media, and brochures. Recruitment materials emphasized general health and included tests for various chronic diseases to reduce self-selection bias for participants with specific conditions.

3.1.1. Demographic characteristics and behavioral factors—Informed consent was obtained from all participants, and approval from the committee for the protection of human subjects was obtained at the three institutions. Age, use of cigarettes and alcohol, province of residence (PH), Philippine province of birth (SD) or origin (HI), and ethnic ancestry (HI and SD) were elicited by self-report through standardized questionnaires. Ethnic ancestry was

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verified by a brief genealogical interview (HI) modeled after the San Antonio algorithm [21]. Physician diagnosed diabetes and use of oral hypoglycemic agents or insulin were determined using structured questionnaires (HI and SD). Physician diagnosed hypertension and use of antihypertensive medication was ascertained by structured questionnaires in all three regions. Height and weight were measured with participants wearing light weight clothing without shoes. Body mass index (BMI) was calculated as kg/m^2.

3.1.2. Laboratory analysis—In the Philippines, fasting glucose after a minimum 8 h fast was measured by the cholestech LDX system using capillary whole blood. Validation of the capillary blood analyzer was performed by comparing capillary test results with whole blood samples analyzed in a Centers for Disease Control (CDC) accredited laboratory in Indonesia. In Hawaii and San Diego, a 75 g oral glucose tolerance test (OGTT) was administered after a minimum 8 h fast; blood samples were obtained by venipuncture at 0 and 2 h. Plasma glucose was measured by a glucose–oxidase method on a Beckman Synchron CX-4 automated analyzer (HI) or in a diabetes research laboratory (SD). Two morning blood pressure readings were recorded while participants were rested and seated, using a mercury sphygmomanometer. The recorded blood pressure was calculated as the mean of the two blood pressure readings.

3.1.3. Case criteria—Fasting hyperglycemia was defined as fasting plasma glucose ≥126 mg/dl or fasting whole blood glucose ≥110 mg/dl after a minimum 8 h fast [22]. Type 2 diabetes was defined using the 1999 World Health Organization criteria (fasting plasma glucose ≥126 mg/dl, or 2-h postchallenge glucose ≥200 mg/dl, or a history of type 2 diabetes diagnosed by a physician, or treatment with an oral hypoglycemic agent or insulin) [22]. Hypertension was defined as antihypertensive medication use or systolic blood pressure ≥130 mmHg or diastolic pressure ≥85 mmHg. Obesity was defined as BMI ≥25 kg/m^2 according to the recommendations of the World Health Organization and the International Task Force on obesity of lower BMI to define obesity among Asians [23], however standard definitions of obesity (BMI ≥ 30 kg/m^2) were also computed.

3.1.4. Sample size exclusions—Several exclusions were made to reduce possible bias due to variations in sampling methodologies across the three groups. Women who were using insulin were excluded to omit those with possible type 1 diabetes from the analysis. The San Diego sample (n = 453) excluded seven participants who were either younger than 40 years or older than 79 years of age or used insulin (n = 1). The Hawaii dataset (n = 457) excluded all 192 men, the 98 women who were not in the 40–79 years age category, and 58 Filipino women who had Native Hawaiian, Caucasian, or Japanese admixture. Data from the Philippines (n = 4389) excluded 2189 men, and 785 women who were not in the 40–79 years age category. Further, the Philippine data was restricted to participants from the National Capital Region, Cavite, Ilocos Norte, Ilocos Sur, and Pangasinan (n = 479), to enable comparability with the regional origin of Filipina migrants in San Diego and Hawaii.

3.1.5. Statistical analysis—Data were analyzed using Statistical Analysis Systems (SAS Version 8.2, Cary, North Carolina). Univariate analysis was performed, including analysis of variance for continuous variables, and chi-square for categorical variables to identify regional differences. Multivariable analysis was performed to adjust for major covariates including age and BMI. Statistical significance was designated at $p < 0.05$ or 95% confidence intervals that excluded 1.

4. Results

The study population included 479 women in the Philippines, 109 women in Hawaii, and 446 women in San Diego. Mean age (57 years) did not vary regionally, however the Philippine cohort had significantly more women in the youngest age category (Tables 1 and 2). Smoking practices differed significantly by region, with ever smokers most frequent in Hawaii (32%) and least frequent in San Diego (16%), while current smoking was highest in the Philippines (19%). Alcohol use (≥3 drinks/week) was rare in all regions. Only 1.3% of the San Diego participants were US born, whereas 36.2% of Filipinas in Hawaii were US born. Further, immigrants in Hawaii had resided in the US for a longer time (26.4 years) compared to immigrants in San Diego (16.5 years).

Mean BMI was significantly lower in the Philippines (22.7 kg/m^2) than in Hawaii (26.0 kg/m^2) or San Diego (25.4 kg/m^2), but did not differ among Filipinas in Hawaii and San Diego (Table 2). Similarly, the prevalence of obesity (WHO Asian obesity definition, BMI ≥ 25 kg/m^2) did not differ among Filipinas in Hawaii (50.5%) and San Diego (49.2%), but was significantly lower among women in the Philippines (28.8%, Table 1). When standard definitions of obesity were applied (BMI ≥ 30 kg/m^2), one-fourth (20.1%) of Filipinas in Hawaii were obese (BMI ≥ 30 kg/m^2) compared to just 5.2% in the Philippines and 9.3% in San Diego.

Mean systolic blood pressure and fasting glucose levels were significantly lower in the Philippines, but did not differ between San Diego and Hawaii. Hypertension prevalence was significantly lower in the Philippines (50%) than in San Diego (57%) and Hawaii (62%) ($p < 0.05$), but did not differ among Filipinas in San Diego and Hawaii. Fasting hyperglycemia prevalence was similar in the Philippines (11.8%), San Diego (14.1%), and Hawaii (14.7%, p-value = 0.323, Table 1) despite regional differences in body size. Further, no risk differences were observed after adjusting for age and BMI; the risk of fasting hyperglycemia among Filipinas in San Diego did not differ compared with women in the Philippines (age and BMI adjusted odds ratio: 1.04 (95% confidence intervals: 0.69–1.6, $p = 0.8$). Similarly, the risk of fasting hyperglycemia did not differ among Filipinas in Hawaii and the Philippines (age and BMI adjusted odds ratio: 1.0 (95% confidence intervals: 0.73–2.4, $p = 1.0$).

Mean fasting plasma glucose did not differ in San Diego and Hawaii, however, postchallenge plasma glucose was significantly higher in San Diego than Hawaii (Table 2). Type 2 diabetes prevalence did not differ between Filipinas in San Diego (31.6%) and Hawaii (24.9%, p-value = 0.79, Table 1) despite the higher prevalence of obesity (BMI ≥ 30 kg/m^2) among Filipinas in Hawaii.

5. Discussion

This study represents the first comparison of fasting hyperglycemia and type 2 diabetes among Filipino women in the Philippines, California, and Hawaii. Similar studies among migrant Japanese and Asian Indian populations in the US, the UK, and Brazil have shown an increased risk of diabetes and obesity among long-term immigrants and first generation progeny, presumably due to adoption of a western diet and lifestyle [6–9]. Likewise, we observed the highest prevalence of categorically defined obesity (BMI ≥ 30 kg/m^2), and hypertension among Filipinas in Hawaii, where one-third were US born, and immigrants resided in the US for a longer period compared to the San Diego sample. Obesity has detrimental metabolic effects, particularly with regard to abnormal glucose metabolism and insulin resistance [24]. However, no significant regional differences in fasting hyperglycemia were observed despite regional differences in body size.

The prevalence of type 2 diabetes could not be determined in the Philippines cohort since OGTT tests were not performed, however, a recent population-based study in the northern Philippines showed the prevalence of OGTT-defined type 2 diabetes ranged from 20% to 27% among 50–65-year-old women; similar to that observed in our San Diego and Hawaii cohorts [25]. Compared to other residents of California and Hawaii, our observed type 2 diabetes prevalence among Filipinas in San Diego and Hawaii exceeds that of the general populations of California and Hawaii. In 1998, type 2 diabetes prevalence among persons ≥45 years of age was estimated to be 9.4–13.4% in California and 7.8–13.0% in Hawaii [26].

Although this is the first study to compare hyperglycemia among Filipino natives and migrants, several limitations must be acknowledged. The samples in Hawaii and the Philippines were population-based, while the San Diego sample was a convenience sample, raising questions about generalizability. However, census data suggests that Filipina participants in San Diego were similar to all Filipinas in the US, with regard to socioeconomic status and education. Further, recruitment efforts in San Diego emphasized postmenopausal health, particularly osteoporosis, and did not focus on diabetes. Approximately, 60% of the Filipinas in San Diego who fulfilled the case criteria for type 2 diabetes were unaware of their diagnosis when they enrolled in the study, thus, sampling bias is an unlikely explanation for their elevated risk for type 2 diabetes. Obtaining an adequate sample size was a concern in Hawaii, which has experienced Filipino migration for a century. Inter-racial marriage is common in Hawaii. Consequently, the sample size of Filipinas without reported Native Hawaiian, Caucasian, or Japanese admixture was small. Finally, the current analysis used secondary data from three independent studies, where clinical evaluations and laboratory assays differed regionally.

Our results are consistent with prior observations of elevated diabetes prevalence among Asian populations that are not generally obese by western standards [3,6]. However, our findings differ from those of Japanese and Asian Indian immigrants, where type 2 diabetes prevalence was lower in their native countries and higher in their adopted countries [6–9]. Exposure to western lifestyle through four centuries of Spanish and American occupation might account for the absence of an increasing risk of type 2 diabetes with immigration and acculturation to American society. Consequently, adoption of a western diet and lifestyle may have taken place in the Philippines, prior to US migration.

This analysis showed that although one-fourth of Filipinas in Hawaii had a BMI ≥ 30 kg/m^2, no difference in type 2 diabetes prevalence was observed compared to Filipinas in San Diego. Further, despite the significantly smaller BMI of women in the Philippines, the risk of fasting hyperglycemia did not differ regionally. Although environmental factors appear to have contributed to increased obesity and hypertension among Filipina immigrants and first generation Filipina–Americans, our findings suggest that Filipino women in the Philippines and the US may have diabetogenic factors that operate independent of obesity. A multi-ethnic study showed that among women with the least visceral fat (≤46 cm^3 by computed tomography) Filipinas had significantly higher prevalence of type 2 diabetes (23%) compared to Caucasian (2%) or African–American women (7%) [16]. Genetic factors may play an important role in the etiology of type 2 diabetes among Filipinas.

Our findings suggest the need for a collaborative research protocol among Filipino populations in the US and the Philippines, using similar clinical evaluations, laboratory methods, and ascertainment of medical and family history of diabetes. Such information could help to identify the pathophysiology of type 2 diabetes in populations that are generally not obese by western standards and facilitate in discerning genetic from environmental factors.

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Table 1

Age-adjusted sample characteristics for Filipinas aged 40–79 years from San Diego, Hawaii, and the Philippines, 1995–2001

Sample characteristics	Philippines (n = 479)		San Diego (n = 446)		Hawaii (n = 109)	
	N	%	*N*	%	*N*	%
Age categories*						
40–49	152	31.7	104	23.3	27	24.7
50–59	100	20.9	148	33.2	32	29.4
60–69	160	33.4	149	33.4	34	31.2
70–79	67	14.0	45	10.1	16	14.7
Born in the Philippines	479	100.0	439	98.7	60	63.8
Years in US (mean, 95% CI)	—	—	16.5 (15.4, 17.5)	26.4 (23.5, 29.2)		
Ever smokers*	147	30.7	70	15.8	35	32.0
Current smokers*	91	18.8	21	4.4	15	13.6
Alcohol (≥3 times/week)†	—	—	5	1.1	5	4.7
BMI ≥ 25 kg/m^{2}*	127	28.8	219	49.2	55	50.5
BMI ≥ 30 kg/m^{2}*	26	5.2	41	9.3	22	20.1
Hypertension (sbp ≥ 130 or dbp ≥ 85 mmHg)†	238	49.9	254	56.5	68	61.6
Fasting hyperglycemia[a]	54	11.8	64	14.1	16	14.7
Diabetes (WHO 1999)	—	—	143	31.6	27	24.9

CI, confidence interval; BMI, body mass index; WHO, World Health Organization.

[a] Fasting plasma glucose ≥126 mg/dl or fasting whole blood glucose ≥110 mg/dl.

* $p < 0.001$.

† $p < 0.05$ (Mantel Haenszel chi-square).

Table 2

Age-adjusted mean values (95% CI) for diabetes risk factors for Filipinas aged 40–79 years from San Diego, Hawaii, and the Philippines, 1995–2001

Variable	Philippines n = 479	San Diego n = 446	Hawaii n = 109
Age	57.2 (56.3, 58.1)	57.6 (56.7, 58.5)	57.9 (56.0, 59.8)
Weight (kg)	51.1 (50.1, 52.0)	59.7 (58.7, 60.6)*	60.5 (58.5, 62.4)*
Height (cm)	150.0 (149.5, 150.5)	153.2 (152.6, 153.7)*	152.3 (151.2, 153.4)*
Body mass index (kg/m^2)	22.7 (22.3, 23.0)	25.4 (25.0, 25.8)*	26.0 (24.8, 26.5)*
Systolic BP (mmHg)	128.5 (126.6, 130.5)	133.1 (131.1, 135.1)*	133.6 (129.6, 137.6)‡
Diastolic BP (mmHg)	80.5 (79.5, 81.6)	79.0 (77.9, 80.0)§	78.3 (76.2, 80.4)
Fasting glucose (mg/dl)	92.0 (89.9, 94.2)||	103.0 (100.6, 105.5)*	109.6 (104.5, 115.1)*
2-h Postchallenge glucose (mg/dl)	—	164.7 (158.7, 170.7)	130.7 (121.0, 141.2)†

BP, blood pressure; CI, confidence interval.

* $p < 0.001$ (reference group, Philippines).

§ $p < 0.05$ (reference group, Philippines).

‡ $p < 0.01$ (reference group, Philippines).

† $p < 0.001$ (reference group, San Diego).

|| $p < 0.05$ (reference group, San Diego).