

# The Prevalence of Type 2 Diabetes Mellitus in a Wisconsin Hmong Patient Population

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## ABSTRACT

**Purpose:** Wisconsin's largest Asian population, the Hmong, may be at high risk for type 2 diabetes. However, there are few population-based studies investigating the prevalence of diabetes in this population. This study compared the prevalence of diabetes between Hmong and non-Hispanic white patients of the University of Wisconsin departments of family medicine, pediatrics, and internal medicine clinics.

**Methods:** The study utilized data from the University of Wisconsin Electronic Health Record Public Health Information Exchange (UW eHealth – PHINEX). The proportion of Hmong patients diagnosed with diabetes was compared with the prevalence of diabetes in non-Hispanic white patients. Multivariate logistic regression was used to control for the differences in age, sex, body mass index (BMI), and health insurance between the two populations.

**Results:** The total prevalence of diabetes in the Hmong patient population was 11.3% compared to 6.0% in the non-Hispanic white patient population ( $P < 0.001$ ). The prevalence of diabetes in Hmong adult patients was 19.1% compared to 7.8% in white adult patients ( $P < 0.001$ ). Compared with non-Hispanic whites, the odds ratio (95% CI) for diabetes, adjusted for age, sex, BMI, and insurance was 3.3 (2.6-4.1) for Hmong patients.

**Conclusion:** Despite being one of Wisconsin's newest immigrant populations, who came from an area of the world with low rates of diabetes, the adjusted relative odds of diabetes in this clinic sample of Hmong patients is 3.3 times higher than its non-Hispanic white counterpart. The results support previous findings of significantly increased diabetes risk in the Hmong of Wisconsin.

## INTRODUCTION

The Hmong people are one of the most recent immigrant groups to arrive in Wisconsin. More than half of the population was born outside the United States in countries such as Laos, Thailand, and Vietnam. The majority of the Hmong entered the

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United States in the 1980s and 1990s after the Vietnam War.<sup>1</sup> During this conflict, the Hmong supported US military operations in Laos. After the takeover of Laos by communist factions, hundreds of thousands of Hmong fled the country seeking safe haven in Thailand.<sup>2</sup> From Thailand, the Hmong resettled in the countries such as the United States, France, and Australia.<sup>2</sup>

According to the University of Wisconsin Extension Applied Population Laboratory report on the Hmong people of Wisconsin, the Wisconsin Hmong population numbered 33,791 in 2000. The 2010 US Census noted a population of 49,240 Hmong in Wisconsin, a change of 46% growth in 10 years.<sup>3</sup> Hmong people make up 0.63% of Wisconsin's total population and the majority (32.9%) of the Asian population in Wisconsin.<sup>1</sup> Wisconsin has the third largest Hmong population in the United States after California and Minnesota. The counties with the most Hmong residents include Milwaukee

County with 23.3% of the population, and Marathon County with 13.2% of the population. Other counties with significant Hmong populations include Brown, Sheboygan, Outagamie, La Crosse, and Dane.<sup>1</sup>

Chronic diseases such as diabetes, cardiovascular disease, and hypertension are unfamiliar to many Hmong Americans.<sup>4</sup> These diseases have been reported at very low prevalence in southeast Asia during the 1980s and 1990s when many Hmong left these countries for the United States.<sup>5</sup> During the 1990s, national health data from countries such as Thailand and Vietnam report the prevalence of diabetes to be between 1.4% and 3.7%.<sup>5</sup>

Early evidence for the growing risk for diabetes in the Wisconsin Hmong population was discovered by Her and Mundt in 2005.<sup>6</sup> The pilot study surveyed a cross-section convenience sample of 144 Hmong community members in 2 Wisconsin

communities. The study measured casual capillary whole blood glucose values and utilized the American Diabetes Association (ADA) definition of a value over 140mg/dL to identify participants at risk for diabetes. Although the study did not obtain the diagnosed prevalence of diabetes, it did reveal 47% of Hmong women and 32% of Hmong men tested had random whole blood glucose values above 140 mg/dL.<sup>6</sup> In addition to this high rate of a diabetes risk found in Wisconsin Hmong communities, other researchers have estimated the prevalence of diabetes in Hmong communities in other areas of the Midwest to be as high as 16%.<sup>7,8</sup> Another study investigating national 2001 Behavioral Risk Factor Surveillance System data noted the prevalence of diabetes in Asians (not specific to the Hmong population) was 60% higher than non-Hispanic whites.<sup>9</sup> Data from the National Health Interview Survey (1997-2008) found Asian Americans to be at significantly higher risk for diabetes compared to whites.<sup>10</sup>

Although Her and Mundt revealed a high risk of diabetes in the Hmong population, currently there is no large population-based study describing the prevalence of diabetes in the Hmong population. The purpose of this study was to use a patient electronic medical record (EMR) database to describe and compare the prevalence of type 2 diabetes mellitus between Hmong and non-Hispanic white patients.

## **METHODS**

### **Setting**

This study utilized data from the University of Wisconsin (UW) Public Health Information Exchange (PHINEX) database. PHINEX includes electronic health record data from patients accessing UW Health primary care from 2007 through 2012 and the program has been previously described in detail elsewhere.<sup>11,12</sup> The objective of the PHINEX project is to link EMRs with population databases to facilitate multidimensional investigations of population health. This study and the larger UW PHINEX database project is approved by the University of Wisconsin-Madison School of Medicine and Public Health Institutional Review Board Research Protocol M2009-1273, Family Medicine/Public Health Data Exchange.

### **Study Population**

The extracted data contain detailed health and demographic information on 504,799 unique ambulatory care patients who visited the UW clinics, spread throughout Wisconsin, for the years 2007-2012. The dataset captured over 16 million encounters. To protect patient confidentiality, any potentially identifying information such as name, date of birth, social security number, and address were removed from the extracted dataset. The patient EMR numbers were replaced with randomly generated accession numbers. The link between the random accession number and the medical record number for each patient was masked before the data was provided to the research team.

For the purposes of this study, it was necessary to classify records by race and ethnicity. The EpicCare EMR (Epic Systems Inc, Verona, Wisconsin) contains discrete data input fields indicating a patient's race and ethnicity. Possible race inputs include American Indian or Alaskan Native, Asian, Black or African American, Native Hawaiian or other Pacific Islander, White, Patient refuses to answer, or Unknown. Possible ethnicity inputs include Hispanic, non-Hispanic, Patient refuses to answer, or Unknown. All patient records indicating non-Hispanic white were stratified into the control subject population. In comparing the Hmong patient data to a standard population, the research team utilized the non-Hispanic white population in Wisconsin as a control population. Exclusion of other minority groups from the control group facilitates the future ability to cross compare the prevalence of the Hmong to other minority groups, as well as to compare those groups to the control population. All records with non-Hispanic Asian designations were selected for further identification of Hmong patients. Hmong patients were identified when they self-reported Hmong language in the language field. Because the Hmong language is unique to the Hmong population, it was assumed that those individuals self-reporting primary use of the Hmong language were in fact Hmong. The language field is used primarily by clinics to identify patients requiring interpretive services. Since it is known that a large portion of the Hmong population requires language interpretation, this selection method was used to define a subset population of Hmong patients. Of the 504,799 total patients, 412,908 (81.80%) were identified as non-Hispanic whites and 964 (0.19%) as Hmong.

### **Variables**

Patient race and ethnicity were coded as either non-Hispanic white or Hmong. Body mass index (BMI) (kg/m<sup>2</sup>) was calculated from the earliest weight and height measurements recorded in the patient's record. Individual records were then classified into the following BMI categories: Normal Weight (BMI < 25), Overweight (BMI 25-30), Obese (BMI > 30) or BMI Missing. Additionally, standard methods of categorization were used to classify children under the age of 18 into BMI categories.<sup>13</sup> Patient age and sex were recorded for each patient record. Health insurance was encoded as Commercial, Medicare, Medicaid, Workers Compensation or No Insurance.

Diabetes diagnosis for each patient record was made by utilizing the International Classification of Disease, 9th Revision (ICD-9) diagnosis codes, laboratory values, and identification of antidiabetic medication prescription. ICD-9 250.x0 and 250.x2 codes, where x can be variable, identify a diagnosis of type 2 diabetes mellitus. Within the EMR there are 2 unique fields for diagnosis input. For each clinical encounter an ICD-9 diagnosis is entered in the encounter diagnosis field. This field is used to identify the diagnosis(es) of each patient visit and also is used for billing. The problem list field is another location where clinicians

**Table 1.** Characteristics of Hmong and Non-Hispanic White Subject Populations

Characteristic	Hmong	Non-Hispanic White	P-value
<b>Number (Percent of Total)</b>	<b>964 (0.19%)</b>	<b>412,908 (81.80%)</b>	
<b>Average Age Years</b>	<b>31.0 ± 0.77</b>	<b>37.8 ± 0.04</b>	<b>&lt;0.001</b>
<b>Age Range in Years (Percentage of Total)</b>			
0-17	392 (40.7%)	96,912 (23.47%)	<0.001
18-54	368 (38.2%)	206,514 (50.0%)	<0.001
55-64	115 (11.9%)	54,495 (13.2%)	0.23
65+	89 (9.2%)	54,987 (13.3%)	<0.001
Total	964	412,908	
Sex % male	43.4%	47.1%	0.022
<b>Mean BMI (kg/m<sup>2</sup>)</b>	<b>24.1 ± 0.48</b>	<b>26.4 ± 0.03</b>	<b>&lt;0.001</b>
<b>BMI Category (Percent of Total)</b>			
Normal weight	282 (29.3%)	135,201 (32.7%)	0.025
Overweight	202 (21.0%)	91,914 (22.3%)	0.333
Obese	152 (15.8%)	94,696 (22.9%)	<0.001
BMI missing	328 (34.0%)	91,097 (22.1%)	<0.001
<b>Health Insurance (Percent of Total)</b>			
Commercial/Workers Comp/No insurance	286 (29.7%)	327,453 (79.3)	<0.001
Medicaid	589 (61.1%)	27,802 (6.7%)	<0.001
Medicare	89 (9.2%)	57,653 (14.0%)	<0.001

Abbreviation: BMI, body mass index

can enter an ICD-9 diagnosis code. This field is used by clinicians to maintain active problems for each patient. In addition to the encounter and problem list diagnostic codes, standard laboratory values also were used to identify patients with diabetes according to the American Diabetes Association definition of type 2 diabetes. The lab values that support the diagnosis of diabetes include a fasting glucose value >126 mg/dL, a 2-hour Glucose Tolerance Test value >200 mg/dL, a random glucose value greater >200 mg/dL, or a hemoglobin A1c >6.5%. Finally, the medication list of each patient was reviewed for prescriptions for antidiabetic medications. Metformin was excluded from the antidiabetic medication class, since it can be used for other conditions such as polycystic ovary syndrome.

Individual patient records were labeled with a diagnosis of type 2 diabetes if both the encounter and problem list diagnoses were consistent for the diagnosis. In addition, if a diagnosis for type 2 diabetes was only found in either the encounter diagnosis or the problem list diagnosis, then the record was labeled with diabetes only after a laboratory value or medication list also supported a type 2 diabetes diagnosis. In circumstances of inconsistencies between type 1 and type 2 diabetes within 1 individual record, a review of the most recent diagnosis was made to determine the most consistent diabetes type diagnosis.

### Statistical Analysis

The statistical analysis of data was performed with SAS software, version 9.3 (SAS Institute Inc, Cary, North Carolina). Individual variables were compared between the Hmong subject population and the non-Hispanic white population with the appropriate sta-

tistical test (*t* test or  $\chi^2$  test) and *P*-values were reported. Multiple step logistic regression was used to calculate odds ratios for type 2 diabetes, adjusting for age, sex, BMI, and health insurance. Due to a high number of missing BMI values, 2 logistic regression models were developed. Model 1 is adjusted for age, sex, and insurance. Model 2 is adjusted for age, sex, insurance, and BMI.

### RESULTS

A total of 964 Hmong patient and 412,908 non-Hispanic white patient records were analyzed in the study. The general patient population characteristics of the Hmong and non-Hispanic white population are shown in Table 1. The Hmong patients were younger than white patients ( $P<0.001$ ) with a large proportion of individuals in the 0-17 age group.

In a portion of patient records from both Hmong and white populations, there was insufficient height and weight data to calculate a BMI. BMI was missing in 34.0% of the Hmong population and 22.1% of the white population. The mean recorded BMI of Hmong records was significantly lower than the mean BMI of white patients ( $P<0.001$ ). The majority of the Hmong patients had Medicaid for insurance (61.1%) compared to only 6.7% of white patients.

### Stratified Diabetes Prevalence Comparisons

The stratified diabetes type 2 crude prevalence comparisons between the Hmong patient population and the white population are shown in Table 2. The overall prevalence of diabetes in the total Hmong population is 11.3%, which is significantly higher than the overall prevalence of 5.97% in the white population ( $P<0.001$ ). The adult Hmong population prevalence for diabetes was 2.54 times higher at 19.1% compared to 7.78% in the adult non-Hispanic white population ( $P<0.001$ ). Hmong individuals within all adult age groups had significantly higher rates of type 2 diabetes than white patients. Significant differences in prevalence of type 2 diabetes between Hmong and white patients, stratified by the BMI category, also were noted by the analysis. Type 2 diabetes was diagnosed in 7.45% of normal weight Hmong compared to only 1.38% of normal weight whites ( $P<0.001$ ) and 19.3% of overweight Hmong compared to 5.24% of overweight whites ( $P<0.001$ ). There was a non-significant difference in prevalence of diabetes in obese Hmong and white patients. In medical insurance stratification, Hmong patients with Medicaid had significantly higher rates of type 2 diabetes compared to whites with Medicaid ( $P<0.001$ ).

**Table 2.** Crude Diabetes Prevalence of Hmong vs Non-Hispanic White Population by Age, BMI Category and Health Insurance

	Hmong		Non-Hispanic White		Odds Ratio (OR)	OR CI	$\chi^2$ P-value
	Number With Diabetes	Diabetes Prevalence	Number With Diabetes	Diabetes Prevalence			
Total Study Population	109	11.3%	24,646	5.97%	2.01	1.64-2.45	< 0.001
Adults (age >18)	109	19.1%	24,585	7.78%	2.79	2.26-3.44	< 0.001
<b>Sex</b>							
Female	79	14.5%	11,653	5.33%	3.01	2.37-3.83	< 0.001
Male	30	7.16%	12,993	6.69%	1.07	0.74-1.56	0.703
<b>Age Range</b>							
0-17	0	0.0%	61	0.06%	—	—	—
18-54	40	10.9%	8108	3.93%	2.98	2.15-4.15	< 0.001
55-64	42	36.5%	7421	13.6%	3.65	2.50-5.34	< 0.001
65+	27	30.3%	9056	16.5%	2.21	1.40-3.47	< 0.001
<b>BMI Category</b>							
Normal weight	21	7.45%	1867	1.38%	5.75	3.68-8.98	< .001
Overweight	39	19.3%	4813	5.24%	4.33	3.05-6.15	< .001
Obese	28	18.4%	15,168	16.2%	1.18	0.79-1.78	0.420
<b>Health Insurance Type</b>							
Commercial/ Workers Comp/No insurance	23	8.04%	13,372	4.08%	2.05	1.34-3.15	< 0.001
Medicaid	56	9.51%	1217	4.38%	2.30	1.73-3.04	< 0.001
Medicare	30	33.7%	10,057	17.4%	2.41	1.55-3.74	< 0.001

Abbreviation: BMI, body mass index

### Adjusted Odds of Diabetes Relative to Non-Hispanic Whites

The results of the multivariate logistic regression analysis are shown in Table 3. Two multivariate logistic regression models were used to adjust for differences between the 2 populations. Model 1 adjusts for age, sex, and insurance and shows the odds of diabetes in the Hmong population compared to the non-Hispanic white population to be 2.3 ( $P < 0.001$ ). After the results were adjusted for age, sex, insurance, and BMI, the odds of diabetes increased to 3.3 ( $P < 0.001$ ).

### DISCUSSION

The results of this clinic-based population study support previous findings that Hmong Americans are at significantly increased risk for developing diabetes.<sup>6,7,14</sup> The risk for diabetes is more than 3-fold higher for a Hmong patient when adjusted for age, sex, BMI, and insurance. The data also indicate the prevalence of diabetes stratified across age group, BMI category, and insurance type is significantly higher in the Hmong population than the non-Hispanic white population. Diabetes is being diagnosed at higher proportions in younger, thinner Hmong patients compared to their white counterparts. The prevalence of type 2 diabetes of Hmong adults in this study at 19.1% supports previous estimates of diabetes prevalence of 16%.<sup>7,8</sup> These data also support previous studies that have shown increased risk for Asians compared to their white counterparts.<sup>9</sup>

Although the study was not designed to determine why Hmong Americans are at increased risk for diabetes, there are sev-

**Table 3.** Odds Ratios of Type 2 Diabetes by Race and Ethnicity

	Non-Hispanic White OR	Hmong OR (95% CI)	Wald $\chi^2$ P-value
Model 1	1.0	2.3 (1.9-2.9)	<0.001
Model 2	1.0	3.3 (2.6-4.1)	<0.001

Abbreviation: OR, odds ratio for diabetes (95% CI).

Model 1 is adjusted for age, sex, and insurance.

Model 2 is adjusted for age, sex, insurance, and body mass index.

eral plausible explanations for this increase in diabetes risk. One possible explanation relates to the changes in environment that greatly affect populations migrating from developing countries to affluent countries.<sup>15</sup> This transition has occurred for the Hmong people who moved from Laos to the refugee camps of Thailand to the United States. In focus group studies, the Hmong have attributed change in environment, leading to factors such as lack of physical activity and poor diet to the development of diabetes.<sup>4</sup> Study participants noted few instances of diabetes in Laos, where the agrarian Hmong practiced labor intensive agriculture.<sup>4</sup>

The clinical implications of this research can be applied directly to patient care. This study supports previous recommendations that health care professionals should be aware of the increased risk for diabetes in the Hmong population.<sup>6,7,14</sup> Physicians should consider screening for glucose intolerance in the Hmong patient population starting at younger ages and lower BMI.<sup>14</sup>

The research findings also suggest future directions for research.

The next step of research should be to obtain a large representative sample of the Wisconsin Hmong population to evaluate the disparity of diabetes prevalence between the general Hmong and non-Hispanic white populations. Further research also should be conducted to explore the relationship of environmental change, genetics, and historical influences on the development of diabetes in the Hmong population.

This research study capitalized on the wealth of data generated by the merging of EMRs from a large health care organization and public health databases. The PHINEX database has allowed researchers to investigate not only the overall health of hundreds of thousands of Wisconsinites, but it also has allowed this research team to specifically identify a minority group to obtain information previously inaccessible. Utilizing the unique race and ethnicity fields will make it possible for other researchers to study specific underrepresented minority groups and compare different health parameters between these groups. The layering of public health data such as socioeconomic, geographic, and educational variables to the health-specific data allows more insight into the interactions between the specific determinants of health and health outcomes.

### Study Limitations

This clinic-based population study has several limitations. The major limitation of this study is the potential for selection bias of the study population. The health information in this study was from ambulatory care patient electronic health records of the UW Health primary care patients. Although the total sample size was very large (504,799 unique records), the sample was a non-random sample of Wisconsin residents, living primarily in south central Wisconsin. Furthermore, the population characteristics and health information from patients of the ambulatory care system might be different from the general Wisconsin population. However, previous studies<sup>11,12</sup> using the PHINEX database found overall that studied health outcomes and demographic characteristics were remarkably similar to Wisconsin's as a whole. Indeed, in this study the crude diabetes prevalence estimate for non-Hispanic white adults (7.8%) was very similar to the comparable Behavioral Risk Factor Surveillance System (BRFSS) state-wide estimate for non-Hispanic white adults in 2012 (7.4%).<sup>16</sup> However, the generalizability of findings still may be of concern if there are meaningful differences between those who seek care and those who do not seek it. This concern may be mitigated by evidence that the majority of Americans are indeed utilizing ambulatory care services. National and state public health surveys have assessed health care utilization of the general population in the United States and in Wisconsin. The 2009 Behavioral Risk Factor Surveillance System reported 80.8% of Americans had primary care providers and 81.65% of Americans were seen for a routine health check up in the last 2 years.<sup>17</sup> The results from The Wisconsin Family Health Survey, 2001-2005, indicate

92% of surveyed Wisconsinites reported having a place of routine health care.<sup>18</sup> Furthermore, 87% of Wisconsin's Asian population surveyed indicated having a place of routine health care.<sup>18</sup> The PHINEX database contains information about UW ambulatory patients that does not include data from other health care systems. Although UW clinics do extend throughout the state, the majority of the database records come from individuals residing in the southern and eastern parts of the state. Differences in UW Health data compared to other system data may have affected identification of diabetes rates among the Hmong and white populations.

Another study limitation is the selection bias when obtaining Hmong patient data. The research team confirmed with clinic registration staff that the language field was used to facilitate interpretive services. It is unknown at the current time how many Hmong patients did not list Hmong in the language field. Hmong ethnicity was not an option for input into the EpicCare EMR. Although the study was able to specifically identify a large number of Hmong patient records, the study likely under-sampled younger, more English-proficient Hmong patients not utilizing interpreter services. The research team did at one point contemplate using Hmong surnames to identify more Hmong patients; however, due to a lack of a validated Hmong surname list as well as the de-identification process, this technique ultimately was abandoned.

A third limitation to the study was the issue of missing data for BMI calculation. Because this dataset was not generated solely for research purposes, it was expected that there would be missing values in certain areas of the medical record. Significant portions of both the non-Hispanic white population and the Hmong population had missing height and/or weight measurements. Records with missing BMI data were not excluded from the general analysis because other valuable information could be obtained from the record. Furthermore, the records missing BMI also were included in the multivariate logistic regression model under the category missing BMI, in addition to BMI categories described above. This step was done to ensure the inclusion of all records in models 1 and 2.

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