Risk Prevalence for Type 2 Diabetes Mellitus in Adult Hmong in Wisconsin: A Pilot Study

Cheng Her, MD; Marlon Mundt, MS

ABSTRACT

Objective: To quantify the proportion that may be at risk for developing type 2 diabetes among a convenience sample of Hmong adults in Wisconsin using the 2000 American Diabetes Association (ADA) Clinical Practice Recommendations for community screening.

Methods: Design was a cross sectional survey. One hundred forty-four participants completed the survey, which consisted of a demographic questionnaire and the ADA Risk Test. Casual capillary whole blood glucose values, blood pressure, height, weight, and waist and hip circumference measures were also recorded. Predictors of positive casual capillary whole blood glucose value (>140 mg/dl) were identified using logistic regression.

Results: Forty-one percent demonstrated positive blood glucose screens on survey. Waist-to-hip ratio was a stronger predictor of a positive screen (Odds Ratio = 3.2 [95% CI: (1.5, 6.2)]) than the ADA Risk Test (Odds Ratio = 2.7 [95% CI: (1.4, 5.1)]).

Conclusions: Hmong adults in Wisconsin demonstrate an increased risk for type 2 diabetes. Present findings are consistent with studies demonstrating increased disease risk in newly arrived populations of industrialized countries.

INTRODUCTION

As refugees of war, the Hmong have undergone much change within the last 2.5 decades since their arrival in the West. Historically an agrarian people subsisting on slash-and-burn agriculture in the highlands of Laos,1-3 Hmong in the United States,4 Europe, and Australia5 have assimilated certain aspects of Western lifestyle. These include language, religion, modes of fashion, food preferences, and differing worldviews.6

This recent chapter in Hmong history mirrors the worldwide transition from subsistence agriculture to a more modern, industrial lifestyle, attributable to the developing global economy of the last half century.7,8 Many features of this contemporary lifestyle are implicated as major contributors to the increasing prevalence of chronic disease states such as type 2 diabetes, in such traditional living populations. For example, sedentary occupations, physical inactivity, and consumption of high-energy fuel resources, such as dietary animal fat are substantial contributors to the development of type 2 diabetes.9 Populations such as Pacific Islanders, Native Americans, migrant Asian Indians and Chinese, Mexican- and African-Americans, Australian Aborigines and Torres Strait Islanders are also included in this high-prevalence group.7-10

The development of type 2 diabetes in these populations is considered by many to only hint at a larger problem termed by the World Health Organization (WHO) as the Metabolic Syndrome.11 Also referred to as the “New World Syndrome,” this disease profile includes obesity, hypertension, dyslipidemia, and glucose intolerance.7,11 The natural course of this disease process, which Zimmet calls “Coca-colanization,” promises to result in a worldwide epidemic of coronary artery disease, peripheral and cerebrovascular disease, and the microvascular complications associated with type 2 diabetes.7,10

Furthermore, familial clustering,12-15 twin concordance studies,16 and studies of migrant populations9,17 implicate genetics as a contributing factor to the development of type 2 diabetes. In concert with certain environmental pressures, the Metabolic Syndrome en-
Molecular and genetic studies have attempted to describe the complex biochemical and physiologic milieu wherein this process is initiated. In particular, obesity and the distribution of body fat have been investigated as risk factors for the development of type 2 diabetes in Japanese-American and Mexican-American individuals. The effects of obesity on insulin sensitivity with increasing age has also been studied.

In 1997 it was estimated that nearly 123 million people worldwide had diabetes. Of this total, 119 million, or 97%, had type 2 diabetes. By the year 2011, it is projected that upward of 213 million individuals worldwide will have type 2 diabetes. In particular, Asia and Africa are expected to have substantial increases in the incidence and prevalence of type 2 diabetes among their populations as industrialization continues to accelerate the development of this and other disease states.

Similarly, diabetes affects nearly 16 million Americans. Of this estimate, 5.4 million are not yet diagnosed. In addition, 90%-95% of the remaining 10.3 million diagnosed with diabetes are estimated to have type 2 diabetes.

Harris et al examined the third National Health and Nutrition Examination Survey, 1988-1994 (NHANES III), to profile the prevalence and trends for both diagnosed and undiagnosed diabetes. This study demonstrated age- and sex-standardized prevalence estimates of both diagnosed and undiagnosed diabetes for all races to be 12.3%. Non-Hispanic whites and non-Hispanic blacks have a prevalence of 11.2% and 18.2%, respectively. Mexican-Americans have a prevalence of 20.3%. There is no specific report of prevalence estimates for Asian-Americans or Pacific Islanders except that the overall estimate of 12.3% for all races includes racial and ethnic groups not specifically mentioned.

However, another study, which analyzed data from 1988 to 1995, reported that diagnosed diabetes among Native Hawaiians is double that of white residents of Hawaii. Still, prevalence data for diabetes among Asian Americans and Pacific Islanders remains limited.

At present the authors are not aware of any international or US data describing type 2 diabetes prevalence or incidence in the Hmong. In parts of Southeast Asia, including Thailand and Vietnam, investigators have documented the prevalence of type 2 diabetes in native populations but there is no specific description of this disease profile among the Hmong who may still be living in these countries. Similarly, studies of diabetes originating from Australia, Hong Kong, Malaysia, Singapore, or the Philippines do not indicate any inclusion of Hmong participants who may have sought refuge in these locales.

Nevertheless, we are personally aware of a striking number of Hmong individuals who are preoccupied with the discussion and development of a traditional approach to the management and cure of “sweet blood,” the Hmong term for diabetes. It remains unclear, however, how many Hmong adults actually carry the diagnosis of diabetes.

Coupled with a 106% increase in the Hmong population of Wisconsin from 1990 to 2000, characterizing type 2 diabetes in Wisconsin Hmong is crucial to the health and productivity not only of this refugee population but also of the community at large.

### METHODS

We conducted a cross sectional risk prevalence survey. Utilizing a community screening approach, data were obtained from Hmong adults at least 30 years of age from 2 sampling frames. Consent forms were available at each of the 2 locales prior to data collection. All

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**Table 1. Description of Study Sample and American Diabetes Association (ADA) Risk Test Responses**

<table>
<thead>
<tr>
<th></th>
<th>Women</th>
<th>Men</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>87</td>
<td>57</td>
<td>144</td>
</tr>
<tr>
<td>Age (Mean)</td>
<td>51.5</td>
<td>47.7</td>
<td>50.0</td>
</tr>
<tr>
<td>Age Range</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-44</td>
<td>33 (38%)</td>
<td>28 (49%)</td>
<td>61 (42%)</td>
</tr>
<tr>
<td>45-64</td>
<td>37 (43%)</td>
<td>18 (39%)</td>
<td>55 (41%)</td>
</tr>
<tr>
<td>65+</td>
<td>17 (20%)</td>
<td>7 (12%)</td>
<td>24 (17%)</td>
</tr>
<tr>
<td>Years in the US (mean)</td>
<td>16.0</td>
<td>17.8</td>
<td>16.7</td>
</tr>
<tr>
<td>No. of Members in Household (Mean)</td>
<td>6.5</td>
<td>6.7</td>
<td>6.6</td>
</tr>
<tr>
<td>Household Size</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-2</td>
<td>6</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>3-5</td>
<td>25</td>
<td>14</td>
<td>39</td>
</tr>
<tr>
<td>6+</td>
<td>56</td>
<td>41</td>
<td>97</td>
</tr>
<tr>
<td>Risk Factors for Diabetes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delivered baby of 9 or more pounds (1)</td>
<td>12 (14%)</td>
<td>NA</td>
<td>12 (14%)</td>
</tr>
<tr>
<td>Sister or brother with diabetes (1)</td>
<td>11 (13%)</td>
<td>5 (9%)</td>
<td>16 (11%)</td>
</tr>
<tr>
<td>Parent with diabetes (1)</td>
<td>11 (13%)</td>
<td>5 (9%)</td>
<td>16 (11%)</td>
</tr>
<tr>
<td>[BMI &gt; 27 kg/m²] (5)</td>
<td>54 (62%)</td>
<td>20 (35%)</td>
<td>74 (51%)</td>
</tr>
<tr>
<td>Less than 65 and get little or no exercise (5)</td>
<td>50 (57%)</td>
<td>23 (40%)</td>
<td>73 (51%)</td>
</tr>
<tr>
<td>45 to 64 years of age (5)</td>
<td>38 (44%)</td>
<td>23 (40%)</td>
<td>61 (35%)</td>
</tr>
<tr>
<td>65 years or older (9)</td>
<td>17 (20%)</td>
<td>7 (12%)</td>
<td>24 (17%)</td>
</tr>
<tr>
<td>ADA Diabetes Risk Test Score, mean (SD)</td>
<td>10.4 (4.5)</td>
<td>7.1 (4.2)</td>
<td>9.1 (4.7)</td>
</tr>
<tr>
<td>ADA Diabetes Risk Test Score &gt;10</td>
<td>58 (67%)</td>
<td>19 (33%)</td>
<td>77 (53%)</td>
</tr>
</tbody>
</table>
forms of written communication, including the consent form, were available in both Hmong and English. Prior to initiating the study, the protocol was approved by the Institutional Review Board of the University of Wisconsin in accordance with the requirements pertaining to the study of human subjects.

The first sample consisted of 82 participants who attended the annual Hmong New Year Festival in November 2000 at an exposition center in Madison, Wis. Prior to the study, local representatives of the Southern Wisconsin Hmong Association were contacted to approve the research. A booth was erected at the exposition center where passersby could ask questions about the posters on display. These posters (in Hmong and in English) described the pathogenesis, screening and diagnosis, treatment, and natural course of diabetes. Those interested in participating completed the questionnaire (described below) and their data were collected in a private area adjacent to the exhibition booth.

The second sample consisted of 62 participants who presented to a community agency in Wausau, Wis, where the same study was being conducted over a weekend in March 2001. Hmong community leaders and representatives of the Wausau Area Hmong Mutual Association were contacted to approve the study. The Wausau Area Hmong Mutual Association offered the use of its office building for data collection as it is centrally located and many Hmong residents know of its location. The association also donated airtime on a local Hmong radio program to broadcast the purpose of the study 1 week prior to data collection. Participants could peruse the posters described above as they entered the conference room to be interviewed. Again, data were collected in a private area of the conference room demarcated by room dividers.

At each of these sites local Hmong interpreters administered the questionnaire and ADA Risk Test. Afterward, the same licensed practical nurse collected the physical data. The first author assisted in the collection of data as necessary. Each participant received $5 cash upon completion.

The questionnaire included name, age, sex, year of arrival in the United States, year of departure from Laos/Thailand, number of household members, prior knowledge of diabetes ("sweet blood"), time of last meal (the latter 62 subjects only), and the ADA Diabetes Risk Test. The physical data included blood pressure (auscultation using appropriately sized manual sphygmomanometers for adults, 1 reading), height (inches), weight (pounds), waist circumference (umbilical level, centimeters), hip circumference (maximal at buttocks, centimeters), casual capillary whole blood glucose by reflectance meter (mg/dl) (Accu-Chek Advantage), and time of blood sampling (the latter 62 subjects only).

We obtained percent body fat and body mass index (BMI) with the TANITA TBF-300GS Body Composition Analyzer/Scale. These estimates are derived from recorded (electrical) resistance, weight, and height using the standard body type as outlined by the manual accompanying the TANITA TBF-300GS.

We used the MINITAB software package to perform statistical analyses on these data. Given some of the extremely high values of casual capillary whole blood glucose, we utilized log transformation of the data for the purposes of analysis. Our final model was the logistic regression equation designating LogLogFingerstick (casual capillary whole blood glucose >140 mg/dl) as the dependent variable on which were regressed age, percent body fat, waist-to-hip ratio, ADA Risk Test score, and sex.

**RESULTS**

The study sample consisted of 87 (60%) women and 57 men. Ages ranged from 28 to 85 years, with a mean age of 50 and a median age of 47. The women in the study were slightly older, on average, than the men, with 20% (17/87) of the women age 65 years or older compared to 12% (7/57) of the men. Most of the participants in the study were not recent refugees to the United States; the average number of years in the United States was 16.7 years (range 6-27 years) (Table 1).

Data on household size were collected as a potential surrogate variable for traditional Hmong lifestyle. It was thought that adherence to the traditional Hmong lifestyle is a potential risk factor for diabetes among Hmong people. Therefore, we recorded the number of household members (Table 2).
lifestyle might be an indicator of reduced risk for type 2 diabetes. Of the subjects in this study, 67% (97/144) lived in households of 6 or more members, with the average number of members per household being 6.6.

The ADA risk test measures 7 risk factors associated with diabetes. Each is assigned a point value (1, 5, and 9) that corresponds to the amount of risk that particular factor carries for type 2 diabetes. A score of 10 or more is considered an indicator of high risk. Women demonstrated greater risk than men on every component of the ADA risk test. In particular, women tended to have higher levels of BMI than men, as based on a BMI >27 kg/m2 (62%[54/87] versus 35%[20/57]). Similarly, of those less than 65 years, women reported less exercise than men (57%[50/87] versus 40%[23/57]). Overall, women in the study sample averaged a risk score of 10.4, with 67% (58/87) having a risk total of 10 or more. Only 33% (19/57) of the men in the study had a risk total of 10 or greater (Table 1).

In accordance with the ADA recommendation for community screening, a casual capillary whole blood glucose value >140 mg/dl was considered a positive screen. Study values ranged from a low of 54 to a high of 539 mg/dl, with an average of 158.6 mg/dl (Table 2). Forty-seven percent (41/87) of the women and 32% (18/57) of the men in the study had casual capillary whole blood glucose values ≥140 mg/dl, for a total of 41% (59/144) positive screens.

The proportion of positive screens increased with age. Percent positive screens increased from 33% (20/61) for those age 25-44 to 44% (26/59) for those age 45-64 until it peaked at 54% (13/24) in those age 65 and older. Women tended to have higher values of casual capillary whole blood glucose in all age groups (Figure 1). In addition, positive screens increased with increasing BMI.

Thirty-seven percent of the sample screened positive for hypertension (systolic blood pressure ≥140 and/or diastolic blood pressure ≥90). Hypertension was positively associated with increased age (Figure 2) and BMI (Figure 3 and 4), but not with elevated fingerstick glucose results.

Waist-to-hip ratio and the ADA Risk score were 2 measures that strongly correlated with positive casual capillary whole blood glucose. Waist-to-hip ratios for the study participants were determined as a measure of the distribution of upper body fat. Though previous studies have established sex-specific at-risk waist-to-hip ratios (>0.8 for women and >1.0 for men) we considered a single, averaged waist-to-hip ratio of ≥0.90 as high risk for both men and women in our analysis. Table 3 compares 2 2X2 contingency tables comparing the predictive value of casual capillary whole blood glucose reading of >140 mg/dl with the predictive value of the waist-to-hip ratio (>0.90) and that of the ADA Risk score (>10).

The overall association between waist-to-hip ratio and a positive casual capillary whole blood glucose reading was stronger than the association between the ADA Risk Test score and a positive reading, as indicated by the odds ratio (3.2, 95% CI: [1.5, 6.2], waist-to-hip versus 2.7 [95% CI: 1.4, 5.1], ADA Risk Test score). In comparison, the ADA Risk Test score exhibited higher sensitivity (68% vs 58%), but lower specificity (56% vs 69%) when compared with the waist-to-hip ratio. Slight modifications in the cutoffs for at-risk waist-to-hip ratio reflecting the fact that women have gynecoid body shapes, which tend to lower waist-to-hip ratios, could improve the sensitivity without loss of specificity.

Logistic regression analysis did not reveal any significant findings for the variables of number of years in the United States or number of members in the household.
BMI and percent body fat were also not significant in this analysis.

**DISCUSSION**

The cross sectional risk prevalence survey was designed to identify risk factors for type 2 diabetes rather than to explicitly define the prevalence of type 2 diabetes in Hmong adults. These data nevertheless demonstrate that 41% are potentially at risk for developing the disease. Given some of the extremely high values observed (Table 2), it would appear that many of the participants could already have or are likely to develop type 2 diabetes.

It is not surprising that waist-to-hip ratio most strongly predicts a positive result on casual capillary whole blood glucose given previous studies demonstrating a relationship between central (abdominal) obesity and type 2 diabetes. This result is also consistent with previous findings of studies of migrant populations and their development of chronic disease states.

Though not as highly correlated with positive casual capillary whole blood glucose as waist-to-hip ratio, older age, female gender, and elevated BMI were also associated with a higher likelihood of positive casual capillary whole blood glucose in this study. These are known risk factors for type 2 diabetes.

Hypertension was not correlated with positive casual capillary whole blood glucose but was observed to be associated with increasing age and elevations in BMI.

It was surprising, however, that the ADA Diabetes Risk Test was not more strongly associated with a positive result on casual capillary whole blood glucose measurement. Nevertheless, 53% (77/144, Table 3) of study participants were identified as being at risk (risk score >10) according to the ADA questionnaire. Of these 77 at risk, 40 (52%) had positive casual capillary whole blood glucose values.

This cross sectional study has several limitations. First, study subjects were recruited from 2 different sampling frames since a representative sample from the adult Hmong population of Wisconsin was not feasible given resource limitations of this pilot study. The initial 82 subjects were recruited from a convenience sample of festival attendees who were not aware of the study prior to attending the festival. The subsequent 62 subjects were recruited from a sample of Hmong adults who were informed of the study via a weekly Hmong radio program. This alternate method may have attracted volunteers who knew or suspected they had diabetes.

Second, the use of casual capillary whole blood glucose as a screening tool is not without controversy. With the 2001 position statement on screening for diabetes, the ADA no longer recommends community screening, not even in high-risk populations, for lack of scientific evidence that screening improves outcomes in morbidity and mortality. Specifically, the position statement argues for less costly methods, which may be more appropriate as the potential risks associated with screening for diabetes are not clearly defined. This is not to say that screening is without merit. Indeed, the ADA clearly recognizes the potential of screening programs as a means to enhance public awareness of diabetes and its complications.

At the time the study was conducted, the ADA 2000 position statement on screening for type 2 diabetes acknowledged that casual capillary whole blood glucose values >140 mg/dl warranted further diagnostic testing and evaluation by a physician. This position statement further reports that whole blood glucose values are 10%-15% lower than plasma blood glucose values. Consequently, investigations utilizing whole blood glu-
Cose samples could ultimately result in more sensitive estimates of the number of individuals at risk for type 2 diabetes, at the cost of decreased specificity.

Moreover, economic limitations and time constraints of the current research prohibited venous sampling of fasting participants to determine the prevalence of diagnosed type 2 diabetes. Additionally, the capillary blood sample was considered less threatening given certain negative connotations that the Hmong have with medical research.22

Third, because of the inherent pitfalls associated with screening tests and the context in which these data were obtained, one can only speculate about the prevalence of diagnosed type 2 diabetes in adult Hmong in Wisconsin.

Given these findings, a hypothesis might assert that the prevalence and incidence of type 2 diabetes in Hmong adults are rapidly increasing from a previously undocumented baseline, either as a function of rapid industrialization and/or the relative gains in life expectancies attributable to the same process of industrialization. Attempting to elucidate this hypothesis further is challenging for several reasons. First, there are no current data describing the incidence or prevalence of type 2 diabetes among the Hmong in their native land.

Second, many Hmong adults cannot speak or read English. This necessarily requires the expertise of interpreters. In addition, attempts to circumvent this language barrier is further complicated by the 2 dialects of Hmong spoken in the United States, each with its own spoken and written variations.

Finally, Hmong are conspicuously cautious and suspicious of Western medicine. Originating in the refugee camps in Thailand, rumors of experimentation, torture, death, and cannibalism at the hands of American doctors have become a part of Hmong folklore.22 Feeding on a collective skepticism that has, in many ways, functioned historically to preserve Hmong social, political, and economic independence, these stories were propagated in an attempt to discourage leaving family behind in order to seek refuge in other countries, and thereby preserve the family unit. So strong is this folklore that Hmong who have lived in the United States for many years and who consider themselves to be Westernized remain suspicious of the intentions of Western medical practitioners.

Nevertheless, documentation of type 2 diabetes among the Hmong is possible. The next phase will determine the prevalence of type 2 diabetes in Hmong adults from a representative sample of those in Wisconsin, Minnesota, and California. This next study will utilize fasting plasma glucose as the currently accepted diagnostic tool and will define more clearly culturally pertinent contributors to obesity as well as type 2 diabetes in this population. Specific questions designed to profile dietary preferences (Hmong or non-Hmong), activity levels (gardening, farming, fishing), educational attainment, and occupation will also be incorporated in this study.

Similarly, an incidence study documenting the development of type 2 diabetes in Hmong adults with and without risk factors may accurately profile the impact of this disease on this population in the years forthcoming. Additional sampling frames may include the Hmong communities of Australia, New Zealand, and France. Ultimately, returning to Southeast Asia and/or China to collect data may provide the baseline information necessary to make comparisons and thereby substantiate (or refute) the aforementioned negative health effects associated with rapid industrialization among the Hmong.

Thus far, Hmong organizations have demonstrated fervent support for this kind of research. Their endorsement will continue to be crucial to the success of future investigations of this sort. Because of their unique role as service entities in the Hmong communities in which they serve, these organizations are ideal partners in the

<table>
<thead>
<tr>
<th>Table 3. Comparison of Waist/Hip Ratio and ADA Risk Test as Predictors of Positive Casual Capillary Whole Blood Glucose</th>
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<tbody>
<tr>
<td>Waist/Hip Ratio X Fingerstick Glucose</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Waist/Hip &lt; 0.9</td>
</tr>
<tr>
<td>Waist/Hip &gt;= 0.9</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ADA Risk Scale X Fingerstick Glucose</th>
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</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>ADA score &lt; 10</td>
</tr>
<tr>
<td>ADA score &gt;=10</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>
implementation of the educational and health initiatives potentially derived from this study and any future studies of Hmong health.

REFERENCES


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The Wisconsin Medical Journal (ISSN 1098-1861) is the official publication of the Wisconsin Medical Society and is devoted to the interests of the medical profession and health care in Wisconsin. The managing editor is responsible for overseeing the production, business operation and contents of the Wisconsin Medical Journal. The editorial board, chaired by the medical editor, solicits and peer reviews all scientific articles; it does not screen public health, socioeconomic or organizational articles. Although letters to the editor are reviewed by the medical editor, all signed expressions of opinion belong to the author(s) for which neither the Wisconsin Medical Journal nor the Society take responsibility. The Wisconsin Medical Journal is indexed in Index Medicus, Hospital Literature Index and Cambridge Scientific Abstracts.

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