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ORIGINAL PAPER

# Disparities in Self-Reported Diabetes Mellitus among Arab, Chaldean, and Black Americans in Southeast Michigan

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**Abstract** Diabetes mellitus is an important public health problem that disproportionately affects minorities. Using a cross sectional, convenience sample, we estimated the prevalence of self-reported diabetes for Whites ($n = 212$), Arabs ($n = 1{,}303$), Chaldeans ($n = 828$), and Blacks ($n = 789$) in southeast Michigan. In addition, using a logistic regression model, we estimated odds ratios and 95% confidence intervals for the association between ethnicity and diabetes before and after adjusting for demographic, socioeconomic status, health care, chronic conditions, and health behavior variables. The overall age- and sex-adjusted prevalence of diabetes was 7.0%. Estimates were highest for Blacks (8.0%) followed by Arabs and Whites (7.0% for each group) and Chaldeans (6.0%). In the fully adjusted model, the association between ethnicity and diabetes was not statistically significant. Future studies should collect more detailed socioeconomic status, acculturation and health behavior information, which are factors that may affect the relationship between race/ethnicity and diabetes.

**Keywords** Arab · Chaldean · Black · Diabetes

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## Introduction

Diabetes mellitus is one of the major modifiable risk factors for coronary heart disease [1–4], stroke [5, 6], and peripheral vascular disease [7, 8]. The prevalence of diabetes (diagnosed and undiagnosed) is approximately 9.3% in the United States population [9]. It is higher for some minority groups, such as Blacks (13.3%) compared to Whites (8.5%) [9]. Although Whites are usually used as the reference category for health comparisons in the US, Whites are a heterogeneous group [10]. According to the Office of Management and Budget, Whites comprise persons having origins in Europe, North America, or the Middle East [10]. Therefore, using Whites as the reference group may miss variations in the health status of other groups within the White category, such as individuals from the Middle East.

Because of the homogeneity assumption assigned to the White category, little attention has been paid to the health status of subgroups within the White category. For example, Arabs/Chaldeans, a subgroup within the White category, may exhibit better or worse health outcomes compared to Whites as a whole [11–18]. The prevalence of self-reported diabetes ranged from 7.0% to 23.0% among Arabs [11, 14–16, 18] and 17.1% [17] among Chaldeans. These studies were conducted in Michigan, because Michigan is home to the highest concentration of Arab and Chaldean Americans in any state (approximately 100,000) [19–21]. Findings from these studies are crucial in helping us better understand the health of Arabs and Chaldeans in Michigan. However, in order to place the health and disease status of Arabs and Chaldeans in the context of other minority populations in Michigan, it would be important to include Blacks in the discourse. Therefore, using data from the 2005 Health Assessment Survey (HAS), this study had two objectives: 1) to estimate and compare the prevalence of self-reported diabetes among Arab, Chaldean, and Blacks to Whites in Southeast Michigan; and 2) to examine the association between race/ethnicity and self-reported diabetes.

## Methods

### Setting and Subjects

The objective of the HAS was to assess the prevalence of and risk factors for various chronic conditions among individuals attending the Arab American & Chaldean Council (ACC) in order to design and implement appropriate prevention and intervention programs for minority communities. The original study included 3,543 individuals 18 years of age and older (approximately 5% of ACC attendees/clients-visitors per year), representing 127 zip codes (from Macomb, Oakland and Wayne counties). The study period was from August 26, 2005 to October 25, 2005. Approval was obtained from Wayne Statue University Institutional Review Board (#0507002615).

### Questionnaire Development

The instrument was based on a standardized health status questionnaire, and included basic demographic, socioeconomic status, health care, health status, and health behavior questions. The instrument was translated into Arabic, pilot tested, and approved by a team of medical, education, research, and public health professionals. All responses were self-reported, including height and weight, which the study staff then used to calculate body mass index (BMI) (kg/m$^2$).

### Procedure

The study was announced to the community through local radio, television, and newspapers. The ACC staff approached potential participants, explained the study, and asked if they would volunteer. The self-administered survey was distributed at churches, mosques, and small businesses. Participants also were given the option of completing the questionnaire and mailing it. A code number was assigned to each survey form to avoid duplication of target participants, because clients may have visited one ACC office twice or more during the data collection period.

### Analysis

Of the 3,543 individuals interviewed, the analyses for this paper were limited to Chaldeans, Arabs, Blacks and Whites. Hispanics were included with the White category because of their small sample size ($n = 28$) and because we specified the analyses with and without Hispanics in the sample, and the differences were negligible. We excluded individuals who identified with an "other" or did not respond to the ethnicity question and who responded "unknown" or did not respond to the diabetes question ($n = 411$). This yielded a final sample size of 3,132 (212 Whites, 789 Blacks, 828 Chaldeans, and 1,303 Arabs) for the analyses.

The outcome for this study was self-reported diabetes collected with the question, "Have you been diagnosed by your doctor with diabetes?" Responses were "yes" versus "no" (referent). The main independent variable was ethnicity, determined by asking, "Which ethnicity are you?" Responses included for these analyses were Chaldean, Arab, Black, or White (referent).

Covariates included several demographic (age, sex, marital status, language spoken/written), socioeconomic status (educational level, employment status, income), health care (health insurance, physician visit, self-rated health), chronic conditions (hypertension, high cholesterol, heart disease, depression, BMI); and health behavior variables (exercise, transportation, smoking status, fruit servings, and vegetable servings). Missing data for all covariates, except age, were included as a separate category. For individuals with missing information for age ($n = 224$), we calculated the mean age for the sample and applied it to those with missing age.

Descriptive statistics and prevalence of diabetes were calculated for the entire sample as well as for the four racial/ethnic groups: (1) Chaldean; (2) Arab; (3) Black; and (4) White. To determine significant differences between groups, $t$-test (for continuous variables) and $\chi^2$ (for discrete variables) were used.

Logistic regression was used to estimate the strength of the association between ethnicity and diabetes. Specifically, six sets of analyses were performed: (1) crude odds ratios (ORs) between ethnicity and diabetes; (2) ORs adjusted for demographic characteristics; (3) ORs adjusted for demographic and socioeconomic status characteristics, (4) ORs adjusted for demographic, socioeconomic status and health care characteristics, (5) ORs adjusted for demographic, socioeconomic status, health care characteristics and chronic conditions, and (6) ORs adjusted for demographic, socioeconomic status, health care characteristics, chronic conditions, and health behaviors. Data management procedures were carried out with SPSS [22].

## Results

The overall age- and sex-adjusted prevalence of self-reported diabetes was 7.0%. Estimates were lower for Chaldeans (6.0%) compared to Whites and Arabs (7.0% for each group) and Blacks (8.0%) ($P > .005$, results not shown). The age-adjusted prevalence of self-reported diabetes was higher for males (9.0%) compared to females (6.0%) ($P < .005$, results not shown).

Table 1 shows descriptive characteristics for the sample. Compared to Whites and Blacks, Chaldeans and Arabs were older, more likely to be married, to have less than a high school education and to be unemployed (all $P$s $< .0001$). While 54.4% of Blacks reported an income of $10,000 or less, they were more likely to have health insurance compared to Chaldeans, Arabs, and Whites. Also, Chaldeans were less likely to rate their health as excellent/very good/good and more likely to have hypertension and high cholesterol compared to Arabs, Blacks and Whites. In addition, heart disease was most prevalent among Arabs, while depression was highest among Whites, and Blacks were more likely to report being overweight or obese (all $P$s $< 0.001$).

Table 2 presents the prevalence of self-reported diabetes by race and ethnicity for each covariate. For all racial/ethnic groups (except Whites), the prevalence of self-reported diabetes increased with age (all $P$s $< 0.01$). Arab males and those who were not married were more likely to have diabetes compared to their counterparts ($P < 0.01$). Chaldeans with less than a high school education were more likely to have diabetes compared to those with a high school diploma or higher ($P < 0.01$). Blacks, Chaldeans and Arabs who were unemployed (including disabled or retired) and Chaldeans and Arabs with an income of $10,000 or less were more likely to have diabetes compared to their counterparts ($P < 0.05$). Whites, Blacks, and Chaldeans with health insurance were more likely to have diabetes compared to their counterparts (all $P$s $< 0.05$). Chaldeans who were overweight or obese also were more likely to have diabetes compared to those with BMI < 25 kg/m$^2$. Arabs who reported they were current or ex-smokers were more likely to have diabetes compared to Arabs who never smoked ($P < 0.01$).

Table 3 presents the unadjusted and adjusted odds ratios with their 95% confidence intervals for the prevalence of self-reported diabetes by race and ethnicity. In the unadjusted model, Chaldeans and Arabs were more likely, while Blacks were less likely to have self-reported diabetes compared to Whites; however, these findings were not statistically significant. A closer examination shows when adjusting for health insurance, physicians visits, and self-rated health in addition to demographic and SES variables in model 3, Chaldeans were two times (OR = 0.48; 95% CI = 0.25−0.93) less likely to report having diabetes than Whites. However, this association was explained in the fully adjusted model (Table 3, Model 5).

## Discussion

Overall, these findings show that the sex- and age-adjusted prevalence of self-reported diabetes was lower for Chaldeans compared to Arabs, Whites, and Blacks residing in Southeast Michigan. In addition, Arab males were significantly more likely to have diabetes compared to Arab females. Furthermore, Chaldeans with low SES were more likely to have diabetes compared to their counterparts. Except for Arabs, those with health insurance were more likely to have diabetes compared to their counterparts. After adjusting for all covariates, the association between ethnicity and diabetes did not reach a significant level. This suggests that there are no differences in the prevalence of self-reported diabetes when comparing Chaldeans, Arabs and Blacks to Whites in Michigan.

Our findings were comparable to some studies, but differed from others. According to the 2004 Michigan Behavioral Risk Factor Survey (MBRFS), the overall prevalence of diabetes was 7.6% [23] compared to 7.0% in our study. In the MBRFS, the prevalence of diabetes was 7.9% for females (6.0% in our study) and 7.1% for males (9.0% in our study) [23]. Furthermore, the prevalence of diabetes was 9.4% for Blacks (8.0% in our study) and 7.3% for Whites (6.0% in our study) [23]. The differences in the prevalence of diabetes between the MBRFS and our study may be because the samples and the sampling designs were different. In addition, the MBRFS compared Blacks to Whites, while our study included Chaldeans and Arabs. The "White" group in the MBRFS may have included some Chaldeans and Arabs, while in our study, Chaldeans and Arabs were specifically identified. Also, the MBRFS is a population-based telephone survey, while ours was a self-administered convenience sample. Nonetheless, our study was important because it included two ethnic groups that have been invisible in the health research, Arabs and Chaldeans.

Only a few studies have examined the prevalence of self-reported diabetes among Arabs and Chaldeans in Michigan [11, 14–18]. They found estimates ranging from

**Table 1** Descriptive characteristics by race/ethnicity, Health Assessment Survey, *n* (%), 2005

| | White ($n = 212$) | Black ($n = 789$) | Chaldean ($n = 828$) | Arab ($n = 1,303$) | Total ($n = 3,132$) |
|---|---|---|---|---|---|
| *Demographics* | | | | | |
| Age (mean, SD)* | 34.0 (±12.7) | 30.2 (±8.3) | 44.7 (±16.4) | 39.0 (±13.0) | 38.0 (±14.0) |
| Age categories* | | | | | |
| 18–39 | 152 (71.7) | 708 (89.7) | 386 (46.6) | 789 (60.6) | 2035 (65.0) |
| 40–54 | 44 (20.8) | 64 (8.1) | 200 (24.2) | 335 (25.7) | 643 (20.5) |
| ≥55 | 16 (7.5) | 17 (2.2) | 242 (29.2) | 179 (13.7) | 454 (14.5) |
| Sex (male) | 54 (25.5) | 51 (6.5) | 277 (33.8) | 473 (36.8) | 855 (27.6) |
| Married* | 85 (41.1) | 99 (12.7) | 592 (72.1) | 989 (76.8) | 1765 (57.0) |
| Language* | | | | | |
| Speak english | 145 (71.8) | 780 (98.9) | 109 (13.3) | 190 (15.3) | 1224 (40.1) |
| Speak/read/write Arabic | 54 (26.8) | 2 (0.3) | 690 (84.2) | 1044 (84.1) | 1790 (58.7) |
| Speak another language | 3 (1.5) | 7 (0.9) | 21 (2.6) | 7 (0.6) | 38 (1.2) |
| Socioeconomic status | | | | | |
| Education (less than high school)* | 43 (20.8) | 59 (7.6) | 357 (43.8) | 595 (46.6) | 1054 (34.3) |
| Employment status* | | | | | |
| Employed | 92 (44.4) | 312 (39.7) | 273 (33.3) | 336 (26.2) | 1013 (32.7) |
| Unemployed/disabled/retired | 115 (55.6) | 474 (60.3) | 548 (66.7) | 948 (73.8) | 2085 (67.3) |
| Income (< $10,000)* | 47 (30.9) | 320 (54.4) | 190 (31.6) | 485 (47.6) | 1042 (44.2) |
| Health care | | | | | |
| Health insurance (Yes)* | 145 (71.1) | 636 (83.1) | 570 (70.5) | 835 (67.1) | 2186 (72.3) |
| Physician visits* | | | | | |
| In the year | 148 (69.8) | 679 (86.1) | 650 (78.5) | 1013 (77.7) | 2490 (79.5) |
| In the last two to five years | 33 (15.5) | 71 (9.0) | 64 (7.7) | 110 (8.4) | 278 (8.9) |
| Don't know | 31 (14.6) | 39 (4.9) | 114 (13.8) | 180 (13.8) | 364 (11.6) |
| Self-rated health* | | | | | |
| Excellent/very good/good | 156 (73.6) | 611 (77.4) | 438 (53.0) | 796 (61.1) | 2001 (63.9) |
| Fair/poor | 51 (24.1) | 149 (18.9) | 367 (44.3) | 447 (34.3) | 1014 (32.4) |
| Don't know | 5 (2.4) | 29 (3.7) | 23 (2.8) | 60 (4.6) | 117 (3.7) |
| Chronic illness | | | | | |
| Hypertension* | 20 (9.7) | 102 (13.1) | 205 (25.4) | 253 (20.0) | 580 (19.0) |
| High cholesterol* | 17 (8.2) | 63 (8.2) | 218 (27.1) | 279 (22.2) | 577 (19.0) |
| Heart disease* | 4 (1.9) | 14 (1.8) | 61 (7.5) | 101 (7.9) | 180 (5.9) |
| Depression* | 55 (28.2) | 109 (14.4) | 99 (12.6) | 266 (21.5) | 529 (17.8) |
| Body Mass Index (<25 kg/m$^2$)* | 28 (15.5) | 68 (9.8) | 174 (23.3) | 211 (19.0) | 481 (17.6) |
| *Health behaviors* | | | | | |
| Ever smoked* | 105 (56.1) | 320 (41.1) | 215 (40.0) | 436 (41.8) | 1076 (42.2) |
| Physically inactive* | 68 (32.1) | 180 (22.8) | 441 (53.3) | 829 (63.6) | 1518 (48.5) |
| Car for transportation (yes)* | 147 (70.0) | 492 (62.7) | 511 (63.0) | 739 (57.9) | 1889 (61.3) |
| Fruit serving/day (none)* | 26 (17.8) | 73 (11.9) | 30 (13.8) | 58 (13.6) | 187 (13.3) |
| Vegetable servings/day (none)* | 15 (10.2) | 37 (6.0) | 14 (6.5) | 45 (10.5) | 138 (9.8) |

* $P < 0.001$

7.0% to 23.0% [11, 14–16, 18]. Only two of the studies specifically examined Chaldeans and found estimates of 17.1% [17] and 10.0% [14]. Hassoun [14] grouped Iraqis and Chaldeans together, and found they reported the highest estimates of diabetes (10.0%) compared to other Arab sub-groups (i.e. Lebanese/Syrian, 4.4%; Palestinian/Jordanian, 6.8%; and Yemeni, 9.8%). In our study, the age- and sex-adjusted prevalence of self-reported diabetes was 6.0% for Chaldeans and 8.0% for those who identified Iraq as their country of origin. This latter estimate is lower than Hassoun's estimate of 10.0%. However, Hassoun's estimates may not have been age- and sex-adjusted, which

**Table 2** Prevalence of diabetes by race/ethnicity, Health Assessment Survey, *n* (%), 2005

| | White ($n = 17$) | Black ($n = 41$) | Chaldean ($n = 98$) | Arab ($n = 118$) | Total ($n = 274$) |
|---|---|---|---|---|---|
| *Demographics* | | | | | |
| Age (mean, SD) | 45.2 (±20.7) | 36.6 (±13.4) | 58.1 (±15.4) | 48.1 (±14.1) | 50.0 (±16.5) |
| Age categories | | | | | |
| 18–24 | 4 (9.8) | 8 (3.7) | 1 (1.3) | 4 (2.7) | 17 (3.5) |
| 25–39 | 4 (3.6) | 18 (3.7) | 14 (4.5) | 29 (4.5) | 65 (4.2) |
| 40–54 | 3 (6.8) | 9 (14.1) | 17 (8.5) | 44 (13.1) | 73 (11.4) |
| ≥55 | 6 (37.5) | 6 (35.3) | 66 (27.3) | 41 (22.9) | 119 (26.2) |
| Total | 17 (8.0) | 41 (5.2) | 98 (11.8) | 118 (9.1) | 274 (8.7) |
| *P*-value | 0.166 | 0.006 | 0.000 | 0.000 | 0.000 |
| Sex | | | | | |
| Male | 8 (14.8) | 5 (9.8) | 40 (14.4) | 60 (12.7) | 113 (13.2) |
| Female | 9 (5.7) | 36 (4.9) | 56 (10.3) | 58 (7.1) | 159 (7.1) |
| *P*-value | 0.061 | 0.253 | 0.097 | 0.002 | 0.000 |
| Marital status | | | | | |
| Married | 7 (8.2) | 8 (8.1) | 77 (13.0) | 74 (7.5) | 166 (9.4) |
| Single | 7 (7.3) | 27 (4.4) | 5 (3.5) | 19 (14.2) | 58 (5.8) |
| Widowed/divorce/separated | 3 (11.5) | 6 (9.4) | 15 (17.6) | 23 (13.9) | 47 (13.8) |
| *P*-value | 0.822 | 0.934 | 0.234 | 0.003 | 0.000 |
| Language | | | | | |
| Speak English | 11 (7.6) | 0 | 4 (3.7) | 10 (5.3) | 65 (5.3) |
| Speak Arabic | 5 (17.9) | 40 (5.1) | 52 (16.4) | 79 (10.0) | 136 (12.0) |
| Read and write Arabic | 1 (3.8) | 0 | 38 (10.2) | 18 (7.0) | 57 (8.7) |
| Speak another language | 0 | 1 (14.3) | 4 (19.0) | 1 (14.3) | 6 (15.8) |
| *P*-value | 0.725 | 0.575 | 0.804 | 0.648 | 0.000 |
| *Socioeconomic status* | | | | | |
| Education | | | | | |
| Less than high school | 5 (11.6) | 5 (8.5) | 60 (16.8) | 61 (10.3) | 131 (12.4) |
| High school or more | 12 (7.3) | 36 (5.0) | 36 (7.9) | 55 (8.1) | 139 (6.9) |
| *P*-value | 0.417 | 0.359 | 0.000 | 0.178 | 0.000 |
| Employment status | | | | | |
| Employed | 7 (7.6) | 11 (3.5) | 10 (3.7) | 24 (7.1) | 52 (5.1) |
| Unemployed | 7 (6.5) | 17 (4.0) | 56 (13.1) | 53 (6.8) | 133 (7.6) |
| Disabled | 2 (33.3) | 12 (29.3) | 22 (29.3) | 31 (22.0) | 67 (25.5) |
| Retired | 1 (50.0) | 1 (20.0) | 7 (15.6) | 10 (40.0) | 19 (24.7) |
| *P*-value | 0.429 | 0.005 | 0.000 | 0.000 | 0.000 |
| Income | | | | | |
| Less than $10,000 | 3 (6.4) | 19 (5.9) | 25 (13.2) | 57 (11.8) | 104 (10.0) |
| $10,000 or more | 9 (8.6) | 14 (5.2) | 30 (7.3) | 36 (6.7) | 89 (6.8) |
| *P*-value | 0.626 | 0.707 | 0.035 | 0.006 | 0.002 |
| *Health care* | | | | | |
| Health insurance | | | | | |
| Yes | 15 (10.3) | 38 (6.0) | 81 (14.2) | 84 (10.1) | 218 (10.0) |
| No | 2 (3.4) | 2 (1.6) | 16 (6.7) | 33 (8.0) | 53 (6.3) |
| *P*-value | 0.046 | 0.003 | 0.001 | 0.237 | 0.000 |
| *Physician visits* | | | | | |
| In the last six months | 12 (12.5) | 30 (6.0) | 82 (15.7) | 89 (12.2) | 213 (11.5) |
| In the last year | 2 (3.8) | 7 (3.9) | 9 (7.1) | 16 (5.7) | 34 (5.3) |
| In the last two years | 1 (5.0) | 2 (3.4) | 3 (7.7) | 2 (2.4) | 8 (4.0) |

**Table 2** continued

| | White ($n = 17$) | Black ($n = 41$) | Chaldean ($n = 98$) | Arab ($n = 118$) | Total ($n = 274$) |
|---|---|---|---|---|---|
| In the last five years | 1 (7.7) | 1 (7.7) | 0 (0.0) | 0 (0.0) | 2 (2.0) |
| Don't know | 1 (3.2) | 1 (2.6) | 4 (3.5) | 11 (6.1) | 17 (4.7) |
| *P*-value | 0.044 | 0.154 | 0.000 | 0.000 | 0.000 |
| *Self-Rated health* | | | | | |
| Excellent | 0 (0.0) | 2 (1.7) | 0 (0.0) | 2 (1.4) | 4 (1.3) |
| Very good | 5 (7.5) | 4 (1.6) | 1 (1.0) | 9 (4.3) | 19 (3.1) |
| Good | 4 (6.2) | 12 (4.8) | 9 (3.0) | 20 (4.5) | 45 (4.2) |
| Fair | 4 (10.3) | 16 (12.5) | 44 (17.3) | 32 (11.2) | 96 (13.6) |
| Poor | 4 (33.3) | 7 (33.3) | 41 (36.6) | 45 (28.0) | 97 (31.7) |
| Don't know | 0 (0.0) | 0 (0.0) | 3 (13.0) | 10 (16.7) | 13 (11.1) |
| *P*-value | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| *Chronic illness* | | | | | |
| Hypertension | 6 (30.0)** | 21 (20.6)* | 61 (29.8)* | 64 (25.3)* | 152 (26.2) |
| High cholesterol | 6 (35.3)** | 10 (15.9)** | 71 (32.6)* | 68 (24.4)* | 155 (26.9) |
| Heart disease | 2 (50.0) | 7 (50.0)* | 27 (44.3)* | 31 (30.7)* | 67 (37.2) |
| Depression | 5 (9.1) | 15 (13.8)* | 24 (24.2)* | 45 (16.9)* | 89 (16.8) |
| *Body Mass Index* | | | | | |
| $<25$ kg/m$^2$ | 2 (7.1) | 3 (4.4) | 11 (6.3) | 17 (8.1) | 33 (6.9) |
| $\geq 25$ kg/m$^2$ | 10 (6.5) | 32 (5.1) | 79 (13.8) | 84 (9.4) | 205 (9.1) |
| *P*-value | 0.908 | 0.789 | 0.002 | 0.536 | 0.045 |
| *Health behaviors* | | | | | |
| Smoking status | | | | | |
| Current or ex-smoker | 7 (6.7) | 16 (5.0) | 30 (14.0) | 49 (11.2) | 102 |
| Never smoked | 6 (7.3) | 25 (5.5) | 20 (6.2) | 54 (8.9) | 105 |
| *P*-value | 0.863 | 0.777 | 0.004 | 0.215 | 0.023 |
| Physical activity | | | | | |
| None | 11 (6.1) | 37 (5.3) | 75 (11.6) | 107 (9.5) | 147 (5.6) |
| Once or twice/week | 3 (15.8) | 1 (2.4) | 13 (13.3) | 9 (7.6) | 83 (30.0) |
| Three or more times/week | 3 (21.4) | 3 (6.0) | 10 (11.8) | 2 (3.3) | 13 (6.2) |
| *P*-value | 0.090 | 0.719 | 0.763 | 0.074 | 0.943 |
| Car for transportation (yes) | 12 (8.2) | 23 (4.7) | 34 (6.7)* | 58 (7.8) | 127 (6.7) |
| *Fruit servings/day* | | | | | |
| None | 1 (3.8) | 2 (2.7) | 2 (6.7) | 3 (5.2) | 8 (4.3) |
| One or two | 8 (7.6) | 25 (5.0) | 12 (7.9) | 3 (5.2) | 68 (6.3) |
| Three or more | 2 (13.3) | 4 (9.3) | 1 (2.9) | 1 (2.2) | 8 (5.8) |
| *P*-value | 0.279 | 0.146 | 0.425 | 0.565 | 0.535 |
| *Vegetable servings/day* | | | | | |
| None | 1 (6.7) | 1 (2.7) | 0 (0.0) | 1 (2.2) | 3 (2.7) |
| One or two | 7 (6.5) | 26 (4.9) | 12 (6.9) | 25 (7.3) | 70 (6.1) |
| Three or more | 3 (12.5) | 4 (8.0) | 3 (10.0 | 1 (2.6) | 11 (7.7) |
| *P*-value | 0.467 | 0.275 | 0.246 | 0.781 | 0.230 |

* $P < 0.001$

** $P < 0.05$

may account for the differences, given that Chaldeans are older than the other groups in both Hassoun's study and our study, which suggests that Chaldeans in Michigan may be older compared to other Arab groups, Whites, and Blacks. Interestingly, in our sample, the age- and sex-adjusted prevalence of self-reported diabetes was 5.0% for individuals who identified Lebanon as their country of origin; 6% for Yemeni individuals; 10% for Jordanians; 14% for

**Table 3** Unadjusted and adjusted odds ratios (95% confidence intervals) for diabetes by race/ethnicity, Health Assessment Survey, 2005

| Race/ethnicity | Unadjusted model OR (95% CI) | Model 1 OR (95% CI)[a] | Model 2 OR (95% CI)[a] | Model 3 OR (95% CI)[a] | Model 4 OR (95% CI)[a] | Model 5 OR (95% CI)[a] |
|---|---|---|---|---|---|---|
| White | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Black | 0.63 (0.35–1.13) | 1.14 (0.59–2.20) | 0.99 (0.51–1.92) | 0.88 (0.44–1.76) | 0.81 (0.39–1.69) | 0.79 (0.38–1.66) |
| Chaldean | 1.54 (0.90–2.64) | 0.73 (0.39–1.35) | 0.65 (0.35–1.22) | 0.48 (0.25–0.93) | 0.56 (0.28–1.13) | 0.59 (0.28–1.21) |
| Arab | 1.14 (0.67–1.94) | 0.78 (0.43–1.43) | 0.69 (0.38–1.26) | 0.63 (0.33–1.19) | 0.60 (0.30–1.17) | 0.67 (0.34–1.03) |

[a] Model 1 adjusted for age, marital status and language; Model 2 additionally adjusted for education, employment status, and income; Model 3 additionally adjusted for health insurance, physician visits, and self-rated health; Model 4 additionally adjusted for hypertension, high cholesterol, heart disease, depression, and BMI; Model 5 additionally adjusted for smoking status, physical activity, transportation, fruit servings, and vegetable servings

other Arab; and 17% for Palestinians. Hassoun analyzed Palestinians and Jordanians as one group, and our findings suggest these two groups may be quite heterogeneous and should be considered separately.

Even though the prevalence of diabetes appears to be high among Chaldeans and Arabs in Michigan, this may not be the case on a national level. According to the National Health Interview Survey, the prevalence of diabetes for Arabs was 4.8% compared to 6.9% for Whites [12]. Again, these differences are probably due to the sample and design of the National Health Interview Survey, or that Arabs in other parts of the US may differ from Arabs in Michigan, with regard to acculturation, for example. The acculturation and diabetes literature shows that greater acculturation is associated with a higher or lower prevalence of diabetes depending on the ethnic group [24, 25]. For Arabs in Michigan, Jaber and colleagues showed that lack of acculturation is associated with dysglycemia [26]. Therefore, one explanation for the differences in the diabetes prevalence estimates comparing the US to Michigan is that Arabs living in other parts of the US may be more acculturated than Arabs in Michigan; therefore, they have a lower prevalence of diabetes.

In order to tease out whether or not Arabs and Chaldeans in Michigan are developing diabetes after immigrating to the US or if it is common in their country of origin, we compared our estimates to those from the World Health Organization (WHO) [27]. According to the WHO, the prevalence of self-reported diabetes for adults (≥30 years of age) in Lebanon was 13.8% in 2004 [27] compared to 8.4% in our study. Similarly, the prevalence of self-reported diabetes was 6.4% for individuals 18 years of age and older in Jordan in 2002 [27] compared to 13.5% in our study. The WHO reported measured, not self-reported, diabetes estimates for Yemen in 2000 [27] (20–70 years of age, 4.6% compared to 7.4% in our study). Finally, the measured prevalence of diabetes in Iraq was 10.4% in 2006 [27] (25–65 years of age) compared to 9.7% in our study. It appears that diabetes was more common in Lebanon compared to the Lebanese in Michigan, but Jordanians in Michigan are more likely to have diabetes compared to those in Jordan. In order to explain these differences using theories of acculturation, future studies should measure the relationship between acculturation and diabetes. Although Jaber et al. [26] showed that lack of acculturation is a risk factor for diabetes, they did not analyze subgroup differences. Once again, our results stress the importance of heterogeneity within the Arab and Chaldean population in Michigan. Finally, in making these comparisons, one should keep in mind that there are differences in study design, samples, and self-reported versus measured diabetes estimates.

While the prevalence of diabetes differed within each racial/ethnic group for selected covariates, none of these associations persisted in the fully adjusted logistic model. It appears for Chaldeans, health insurance, physician visits, and self-rated health may affect the relationship with diabetes, since this was the only statistically significant finding. In fact, when compared to Whites, Arabs, or Blacks, the prevalence of diabetes was higher for Chaldeans who reported they had health insurance (14.2%), who visited their physician in the last six months (15.7%), and who rated their health as fair or poor (53.9%). It may be that individuals with health insurance are more likely to seek care and be diagnosed with diabetes in a routine physical exam. Nevertheless, future studies should explore the effects of these three variables on diabetes in depth.

Among the strengths of this study is that it addressed limitations of other studies (did not compare their estimates to other minority groups, used dated information, or had a small sample size) [11, 12, 14–17]. As mentioned earlier, neither the state level study [23] nor the local community studies [11, 14–17] compared Arab and Chaldean estimates to Whites or minority groups. Our study is unique in that it includes Whites and Blacks as comparison groups, which is important given that these groups live in the same areas and may be exposed to the same risk factors for diabetes. In addition, the large sample size in our study allowed us to control for numerous potential confounders. Given this, however, it is important to acknowledge the shortcomings that may have affected our results. The first is that this study was a convenience sample; therefore, perhaps only healthy (or unhealthy) individuals or those who were available during the study times and days may have volunteered. Future studies should utilize a random probability sample in order to account for the reasons why individuals volunteer. For example, one of the reasons for the observed older age among Chaldeans is that the younger groups may have been working during the days and times that the study was offered. In addition, the survey was distributed at churches, mosques, and small businesses, and perhaps older Chaldeans were more likely to attend these places compared to younger Chaldeans.

Although age may have affected the prevalence of self-reported diabetes, our estimates accounted for the differences in age by reporting sex- and age-adjusted estimates. We specified a logistic regression model excluding the individuals with missing age and with mean age as a proxy for missing age, and the results were negligible. Therefore, we reported the latter estimates. Research suggests that Blacks develop diabetes at younger ages compared to whites [28], and this may be why we observed a higher prevalence of self-reported diabetes for Blacks compared to other groups. In addition, the prevalence of diabetes was self-reported, and studies have shown anywhere from one-half to one-third of individuals with diabetes are undiagnosed [9, 29]. These limitations would have only underestimated our study's results. Nevertheless, future studies should collect blood samples in order to detect individuals with undiagnosed diabetes and pre-diabetes, given that both of these conditions are on the rise [9, 29].

This study underscores the importance of examining chronic conditions in a sample of minorities residing in southeast Michigan. Specifically, our study shows that the prevalence of diabetes is lower for Chaldeans compared to Arabs, Whites, and Blacks. Future studies should include a probability sample of Arabs, Chaldeans, Blacks and Whites, because such studies would remove the inherent biases in convenience samples, such as self-selection. Other than Chaldeans, future studies should include individuals of Lebanese ancestry given that they comprise a high proportion of Arabs in Michigan [20, 21]. In addition, these studies should incorporate better measurements of SES, health behaviors, health care, and especially questions regarding acculturation and language use. This type of research will provide more detailed information about this population, and highlight the potential areas where intervention and prevention programs would be most effective in reducing the prevalence of and risk factors related to diabetes.

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