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ORIGINAL PAPER

# High Rates of Diabetes Mellitus, Pre-diabetes and Obesity Among Somali Immigrants and Refugees in Minnesota: A Retrospective Chart Review

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**Abstract** We examined the prevalence of cardiovascular risk factors among Somali refugees at a midwestern hospital in the U.S. This was a retrospective cohort study of 1007 adult Somali patients and an age and frequency-matched cohort of non-Somali patients actively empanelled to a large, academic primary care practice network in the Midwest United States between January 1, 2011 and December 31, 2012. Cardiovascular risk factors were obtained by chart review and compared between the two cohorts using a Chi squared test. Median age was 35 years (Q1, Q3; 27, 50). The prevalence of diabetes was significantly higher among Somali versus non-Somali patients (12.1 vs 5.3 %; $p = 0.0001$), as was prediabetes (21.3 vs 17.2 %; $p < 0.02$) and obesity (34.6 vs 32.1 %; $p = 0.047$). After adjusting for age, sex, body mass index, education and employment, among the Somali patients, the odds ratio (95 % confidence interval) for diabetes was 2.78 (1.76–4.40) and 1.57 (1.16–2.13) for pre-diabetes. There was a significantly higher prevalence of diabetes, pre-diabetes and obesity among Somali patients compared with non-Somali patients. Further research into the specific causes of these disparities and development of targeted effective and sustainable interventions to address them is needed.

**Keywords** Somali · Cardiovascular risk factors · Diabetes · Prediabetes

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## Introduction

The number of African-born immigrants to the United States has increased rapidly, doubling in size between 2000 and 2010 [1]. Refugees and immigrants from the East African nation of Somalia began arriving in the U.S. in the early 1990s, after civil war broke out in their home country [2]. Over the last two decades, they constitute almost half of all African refugees arriving in the US and 40 % have settled in the state of Minnesota [2].

Coronary artery disease is the leading cause of death in the world [3], and diabetes mellitus, hypertension, hyperlipidemia, smoking and obesity, through myriad mechanisms, are the strongest predictors of the disease [4–6]. Among immigrant and refugee groups in general, the longer they reside in the U.S., the more their cardiovascular risk profiles approximate those of the general population including rising rates of diabetes, hypertension, hyperlipidemia, and obesity [7]. However, this phenomenon is heterogeneous between different immigrant groups and between different risk factors [8]. It is important to understand this heterogeneity so that clinical practice interventions and research may be tailored to specific populations.

The data regarding cardiovascular risk among African immigrants to high-income countries in general are mixed, depending on the specific risk factor and immigrant group

[9, 10]. The prevalence of diabetes mellitus among African immigrants to the U.S. has not been reported, but a study of 10,000 men in Israel, and a systematic review of 18 studies of North African immigrants to Northern Europe, found a higher incidence of diabetes mellitus among African immigrants compared to other groups [11, 12].

In one cross-sectional study, African immigrants had a lower prevalence of hypertension compared to U.S. born African Americans, even after controlling for body mass index (BMI) and age [13]. Similarly, a study of recent African immigrants to the U.S. reported lower rates of obesity compared with the general population [14], while a study of adolescents found the opposite [15]. Data on dyslipidemia among African immigrants is very limited; in one study of 95 men, levels of triglycerides and high density lipoprotein (HDL)-cholesterol were similar among African immigrants and African Americans, while serum cholesterol was lower among Ethiopian immigrants in Israel [16, 17].

The prevalence of cardiovascular risk factors including diabetes, prediabetes and obesity among Somali immigrants and refugees to high-income nations has not been well described. A single study of 72 Somali psychiatric inpatients documented a higher prevalence of diabetes mellitus and hypertension compared to the general U.S. population [18]. A recent narrative review of cardiovascular disease among Somali persons in the diaspora highlighted the need for more research on this topic [10]. In this study, we compared the prevalence of cardiovascular risk factors between Somali and non-Somali patients at a midwestern hospital in the U.S.

## Methods

This was a retrospective cohort study of adult patients actively empanelled to a large academic primary care practice in Minnesota across four sites and two departments (Family Medicine and Internal Medicine) between January 1, 2011 and December 31, 2012. Active empanelment was defined as having a primary care provider in this practice and having been seen in the practice within this 2-year period. To identify the Somali cohort, we used a natural language processing algorithm that has demonstrated accuracy and precision in identifying Somali patients from the electronic medical records (EMR) of these practices [19]. The algorithm was applied to the records of all actively empaneled adult patients (approximately 130,000). The Somali cohort was confirmed by chart review. To identify the non-Somali cohort, we performed frequency matching by age quartiles (17–27, 27–34, 34–48, and 48 and older) of the Somali population. Study procedures were approved by the Institutional Review Board.

### Data Collection

Data on age, gender, race/ethnicity, BMI, Charlson comorbidity scores, education level, employment status, and time since first visit were obtained from patients' registration information in the EMR. Information on cardiovascular risk factors, including a diagnosis of type 2 diabetes mellitus, prediabetes, hypertension, uncontrolled hypertension, dyslipidemia, overweight, and obesity within 5 years of the study period (January 1, 2008 through December 31, 2012) was abstracted through chart reviews by a physician. Type 2 diabetes mellitus diagnosis was defined as a provider-generated diagnosis of diabetes mellitus documented in the EMR. A diagnosis of prediabetes was defined as fasting blood sugar between 101 and 125 mg/dL. Hypertension was defined as a provider-generated diagnosis of hypertension documented in the EMR, and uncontrolled hypertension was defined by the most recent blood pressure >140/90 mm Hg in the EMR among patients with a provider-generated diagnosis of hypertension. Dyslipidemia diagnosis was defined by a provider-generated diagnosis of dyslipidemia documented in the medical record. Overweight and obesity were defined as most recent documented body mass index [calculated as weight (kg)/height ($m^2$)] of 25–29.9 and ≥30 respectively. Identification of diagnoses through EMR clinical notes (diagnoses and problem lists) in this fashion is superior to use of billing data [20]. Further, our physician-abstraction attenuates the primary limitation of EMR-derived diagnoses through administrative datasets, namely the lack of a common dictionary [21].

### Data Analysis and Modeling

Baseline characteristics of Somali and non-Somali patients were compared using a Chi squared test for categorical variables. Logistic regression models were used to compare prevalence of cardiovascular risk factors for Somali versus non-Somali patients and are presented as odds ratios (OR) with 95 % confidence intervals (CI). Multivariable models were used to adjust for the effect of age, sex, education level, employment, time from first visit and BMI. To describe the rate of disease by age, the percentage of Somali and non-Somali patients with cardiovascular risk factors were compared using a Chi squared test for proportions for those <50 years old and ≥50 years old. All analyses were performed using SAS, Version 9.3 (SAS Institute, Cary, NC).

## Results

Overall, Somali patients had lower education levels, were less likely to be employed, and had higher Charlson comorbidity scores compared to matched non-Somali patients (Table 1). The prevalence of diabetes mellitus was significantly higher among the Somali patients compared to the non-Somali patients (12.1 vs 5.3 %; $p < 0.0001$; Table 1). Somali patients also had a higher prevalence of prediabetes (21.3 vs 17.2 %; $p < 0.02$), and more patients who were obese (34.6 vs 32.1 %), and overweight (33.2 vs 30.4 %; $p = 0.047$). The prevalence of hypertension (17.0 vs 15.5 %; $p = 0.38$) and uncontrolled hypertension (5.0 vs 6.2 %; $p = 0.25$) was similar in both groups. The prevalence of dyslipidemia among the Somali patients was lower than that of the non-Somali cohort (18.1 vs 21.6 %; $p = 0.048$).

After adjusting for age, sex, BMI, education level, employment status, time since first visit, and BMI, there was an increased odds of the having diabetes mellitus, prediabetes, or either, OR (95 % CI) of 2.78 (1.76–4.40), 1.57 (1.16–2.13) and 2.29 (1.70–3.10), respectively for Somali

**Table 1** Baseline characteristics of Somali and non-Somali patients in a primary care setting (N = 2017)

| | Somali N = 1007 | Non-Somali N = 1010 | *p* value[a] |
|---|---|---|---|
| Age | | | |
| 17–29 | 341 (33.9) | 335 (33.2) | |
| 30–39 | 262 (26.0) | 255 (25.3) | |
| 40–49 | 165 (16.4) | 167 (16.5) | 0.87 |
| 50–59 | 102 (10.1) | 112 (11.1) | |
| 60–69 | 73 (7.3) | 66 (6.5) | |
| ≥70 | 64 (6.4) | 75 (7.4) | |
| Sex | | | |
| Female | 616 (61.1) | 575 (56.9) | 0.07 |
| Male | 391 (38.8) | 435 (43.1) | |
| Race | | | |
| White | 0 (0) | 870 (87.0) | |
| Black | 757 (75.8) | 30 (3.0) | <0.0001 |
| Asian/NH/PI | 0 (0) | 39 (3.9) | |
| Other | 242 (24.2) | 61 (6.1) | |
| Education | | | |
| ≤8th grade—high school degree/GED | 667 (73.5) | 208 (22.2) | <0.0001 |
| Some college/2 year degree—postgraduate studies | 241 (26.5) | 729 (77.8) | |
| Employed | | | |
| Yes | 330 (35.6) | 616 (65.7) | <0.0001 |
| No | 596 (64.4) | 322 (34.3) | |
| Diabetes (Y) | 122 (12.1) | 53 (5.3) | 0.0001 |
| Prediabetes (Y) | 214 (21.3) | 173 (17.2) | 0.02 |
| Hypertension (Y) | 171 (17.0) | 157 (15.5) | 0.38 |
| Uncontrolled hypertension (Y) | 50 (5.0) | 62 (6.2) | 0.25 |
| Dyslipidemia (Y) | 182 (18.1) | 218 (21.6) | 0.048 |
| BMI | | | |
| Underweight/normal | 325 (32.3) | 379 (37.5) | |
| Overweight | 334 (33.2) | 307 (30.4) | 0.0466 |
| Obese | 348 (34.6) | 324 (32.1) | |
| Charlson index | | | |
| 0 | 544 (54.2) | 600 (60.2) | |
| 1 | 255 (25.4) | 222 (22.3) | 0.03 |
| ≥2 | 204 (20.3) | 175 (17.6) | |

[a] *p* value from Chi square test for categorical variables

patients as compared to non-Somali patients (Table 2). However, the adjusted OR of dyslipidemia for Somali patients compared to non-Somali patients was 0.65 (0.47–0.91) (Table 2).

When we compared the rates of cardiovascular risk factors between Somali and non-Somali patients by age (<50 years old versus ≥50 years old), we found that rates of diabetes were higher among the Somali patients, both in the younger (5.5 vs 1.7 %, $p < 0.0001$) and older (33.9 vs 15.85 %; $p < 0.0001$) age groups, while rates of prediabetes were higher among the younger Somali age group (16.4 vs 10.6 %; $p = 0.0009$), (Table 3). On the other hand, the rate of obesity was higher among the older Somali patients. Although the numbers were small in both groups, the rate of uncontrolled hypertension was higher in the younger non-Somali group, (Table 3).

## Discussion

In this study, we report a high prevalence of cardiovascular risk factors, including diabetes mellitus, prediabetes, and obesity among a large cohort of Somali patients compared with non-Somali patients. The high prevalence of diabetes mellitus (12.1 %) and prediabetes (21.3 %) was particularly striking in this relatively young cohort (median age = 35 years) of Somali patients.

The diabetes mellitus data are consistent with previous studies demonstrating higher diabetes prevalence among African immigrants compared with Israeli [12, 22] and Northern European populations [11]. Our study extends these findings to a sub-set of the Somali population in North America. To our knowledge, this study is also the first to document prevalence of prediabetes among African immigrants. Since Somali immigrants and refugees represent the largest influx of African migration to North America over the past two decades, the public health and practice implications of these findings are significant. The relatively young age of our cohort is representative of the Somali population in the U.S., heralding a warning of future diabetes-related morbidity and mortality unless targeted interventions are deployed. This stark speculation is compounded by existing health disparities in diabetes management outcomes among Somali patients in the U.S. [23].

The reasons for the higher prevalence of these cardiovascular risk factors among Somali patients are multifaceted, complex, and not fully understood. A study of type 2 diabetes mellitus in the Middle East and East Africa showed the highest prevalence of disease in the more industrialized countries of Kuwait (21.2 %), Lebanon (20.1 %), and Qatar (20.1 %), whereas Somalia had the lowest prevalence (4.2 %) [24]. The high prevalence of cardiovascular risk factors among Somali immigrants to the U.S. is likely mediated by the impact of the migration experience on eating and physical activity practices. Indeed, a study of dietary behaviors among low-income White, Hmong, Latino and Somali adolescents who had recently immigrated to the U.S. showed that the Somali cohort consumed disproportionately more types of food associated with weight gain and engaged in unhealthy eating behaviors more frequently [15]. Furthermore, levels of moderate to vigorous physical activity among foreign-born youth and young adults are lower when compared to their U.S.-born counterparts [25]. The mediators of these behavioral changes are likewise multidimensional, complex and highly variable across different communities, and according to different socio-economic, environmental and cultural factors [26].

Obesity is the most important risk factor for type 2 diabetes, and worldwide, rising rates of obesity have been associated with an increase in the prevalence of the disease [27, 28]. In our study the rates of diabetes and prediabetes among the Somali patients remained significantly higher

**Table 2** Association between CV risk factors for Somali versus non-Somali patients

| | Unadjusted OR (95 % CI) | Adjusted[a] OR (95 % CI) |
|---|---|---|
| Diabetes | 2.49 (1.78–3.48) | 2.78 (1.76–4.40) |
| Pre-diabetes | 1.30 (1.04–1.63) | 1.57 (1.16–2.13) |
| Diabetes or pre-diabetes | 1.65 (1.36–2.02) | 2.29 (1.70–3.10) |
| Hypertension | 0.90 (0.71–1.14) | 1.14 (0.78–1.65) |
| Uncontrolled hypertension | 1.25 (0.85–1.84) | 1.56 (0.94–2.60) |
| Dyslipidemia | 0.80 (0.64–0.998) | 0.65 (0.47–0.91) |
| Overweight and obesity (BMI ≥ 25) | 1.26 (1.05–1.51) | 1.17 (0.92–1.49)[b] |

Logistic regression modeling odds of cardiovascular risk factor with non-Somali as the referent group

[a] Adjusted for age, sex, BMI, education, employment and time since first visit (except for overweight and obesity)

[b] Adjusted for age, sex, education, employment and time since first visit (for overweight and obesity only)

**Table 3** Rates of cardiovascular disease risk factors by age

| | <50 years | | | ≥50 years | | |
|---|---|---|---|---|---|---|
| | Somali N = 768 N (%) | Non-Somali N = 757 N (%) | *p* value | Somali N = 239 N (%) | Non-Somali N = 253 N (%) | *p* value |
| Diabetes | 41, 5.3 | 13, 1.7 | 0.0001 | 81, 33.9 | 40, 15.8 | <0.0001 |
| Prediabetes | 126, 16.4 | 80, 10.6 | 0.0009 | 88, 36.8 | 93, 36.8 | 0.9888 |
| Hypertension | 51, 6.6 | 48, 6.3 | 0.8122 | 120, 50.2 | 109, 43.1 | 0.1132 |
| Uncontrolled hypertension | 12, 1.6 | 26, 3.4 | 0.0190 | 38, 16.0 | 36, 14.3 | 0.5898 |
| Dyslipidemia | 60, 7.8 | 85, 11.2 | 0.0230 | 122, 51.1 | 133, 52.6 | 0.7354 |
| BMI | | | | | | |
| Under/normal | 286, 37.2 | 307, 40.6 | 0.3827 | 39, 16.3 | 72, 28.5 | 0.0052 |
| Overweight | 243, 31.6 | 221, 29.2 | | 91, 38.1 | 86, 34.0 | |
| Obese | 239, 31.1 | 229, 30.3 | | 109, 45.6 | 95, 37.6 | |

than for the non-Somali patients even after controlling for BMI. In fact, the rates of prediabetes were higher among the younger Somali patients, although their rates of overweight and obesity was similar to that of the non-Somali patients. This is particularly important given the natural history of prediabetes and the risk of developing diabetes. The reasons for this are unclear, and further research is needed to prospectively confirm this finding and to elucidate potential environmental mechanisms.

Traditionally, the diet in the Somali community includes high meat and carbohydrate intake that may shift towards less healthy manifestations of these macronutrients after arrival to the U.S. (e.g., less lean protein, more refined carbohydrates) [29]. Furthermore, pre-existing values surrounding body shapes may influence food choices, where a higher BMI may be associated with happiness, wealth, food security and social stability [30, 31]. However, cultural factors are not fixed variables that occur independently from the contexts in which they are embedded. Instead, food choices are strongly influenced by social, economic, and environmental factors [32]. Prior to their arrival in the United States, many Somalis lived within refugee camps and war-torn areas [33], likely influencing their adjustment to the U.S. food environment [15]. Coming from a poor country (2011 per capita income of $600) [34], they often remain socio-economically challenged upon arrival to the U.S. Socio-economic position has been associated with food insecurity and suboptimal food choices among non-immigrant populations in the U.S. [35]. The socioeconomic risk for food insecurity among Somali immigrants and refugees may be further heightened by financial commitments to support relatives in Africa [36]. Further, one significant change for African immigrants to the U.S. is a persistent exposure to a myriad of foods with a high salt, sugar and fat content that are relatively cheap and easy to obtain within the widespread fast food market [26, 37]. These difficulties navigating the food environment in the U.S. are further compounded by limited English proficiency, which creates an additional barrier to the utility of nutritional information on food packaging [38].

In addition to dietary changes, levels of physical activity often worsen after immigration to the U.S. [39–41]. Reasons are complex, but are broadly related to socioeconomic barriers, including low education and literacy, as well as poverty, which affect capacity to pay for exercise facilities and transportation [42, 43]. Other barriers to physical activity include competing priorities such as child care [44], cultural barriers like lack of exercise facilities that accommodate gender-appropriate cultural norms, embarrassment about foreign exercise clothing and lack of familiarity with exercise equipment [45–47]. Environmental factors such as low perceived safety, new climate/weather barriers, and less walking opportunities with low access to recreational facilities likewise play a role in this disparity [48].

In total, the shared experience of poverty, limited English proficiency, and recent immigration play a formative role in reduced levels of physical activity after immigration [49]. Therefore, targeted interventions are needed to improve opportunities for physical activity among Somali immigrants and refugees to the U.S. Provision of women-only facilities for exercise, and availability of child care, for instance, has been shown to promote participation in physical activity among Somali women [50]. Addressing barriers to access and navigation of the system while acknowledging and harnessing the important role of support from family, friends and the community [51–53] may help to promote physical activity among these populations, and therefore reduce cardiovascular risk.

Our study has limitations. It was retrospective and relied solely on medical records, but missing data were minimal. The study was also based upon patients empanelled to a primary care practice, and the results may not reflect the prevalence of these cardiovascular risk factors within the

larger community. Despite our physician-abstracted chart review to identify diagnoses, the reliance on provider-generated diagnoses and problem lists may lack accuracy, though this limitation should be similar between groups. Additionally, use of a single fasting glucose measurement to identify prediabetes may overestimate this diagnosis. Conversely, the fact that 52 % of total patients did not have a fasting glucose value recorded during the study interval may underestimate this diagnosis, though this occurred similarly in both groups (50 % for Somali patients vs 54 % for non-Somali patients, $p > 0.05$). This study was conducted among patients in a single geographic region within one medical center, which has implications for generalizability to other populations and practices. However, the study included a very large Somali cohort in the state with the largest Somali population in the U.S. We were unable to assess for duration of stay in the US, which may be associated with development of obesity and diabetes.

## Conclusion

In summary, we found a high prevalence of diabetes mellitus, prediabetes, and obesity, which are important risk factors for cardiovascular disease, among a large cohort of Somali patients in the United States. This suggests the possibility of significant diabetes-related morbidity and mortality to come unless targeted interventions are deployed among this rapidly growing population. Further research into the specific causes of these disparities and development of targeted effective and sustainable interventions to address them is needed.

**Compliance with Ethical Standards**

**Conflict of interest** None.

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