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Newly diagnosed type 2 diabetes in an ethnic minority population: clinical presentation and comparison to other populations

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ABSTRACT

Objective To characterize the clinical presentation of newly diagnosed type 2 diabetes of ethnic minority adults in Chicago and compare with other populations.

Research design and methods Cross-sectional study examining the data of 2280 patients newly diagnosed with type 2 diabetes treated between 2003 and 2013 in a large Chicago public healthcare system.

Results Mean age of the patients was 49±11.3 years, men 54.4%, African-Americans 48.1%, Hispanics 32.5%, unemployed 69.9%, uninsured 82.2%, English-speaking 75.1%, and body mass index was 32.8±7.4 kg/m^2. Microvascular complications were present in 50.1% and macrovascular complications in 13.4%. There was a presence of either macrovascular or microvascular complications correlated with older age, hypertension, dyslipidemia, inactivity, speaking English, and being insured (p<0.01). Glycosylated hemoglobin A_{1c} (HbA_{1c}) at presentation did not correlate with diabetes complications. In our cohort, when compared with a diverse population in the UK and insured population in the USA, HbA_{1c} at presentation was 10.0% (86 mmol/mol), 6.6% (49 mmol/mol), and 8.2% (66 mmol/mol); nephropathy was 22.2%, 16.7%, and 5.7%; retinopathy was 10.7%, 7.9%, and 1.4%; and neuropathy was 27.7%, and 6.7% in the UK (p<0.001). There were no significant differences between groups in the prevalence of macrovascular complications.

Conclusion These results show the vulnerability of underserved and underinsured patients for developing diabetes complications possibly related to a delayed diagnosis.

Significance of this study

What is already known about this subject?

- Patients with newly diagnosed type 2 diabetes usually harbor the disease for a few years before being diagnosed. These patients occasionally present with complications at the time of diagnosis.

What are the new findings?

- In underinsured ethnic minority patients with newly diagnosed type 2 diabetes, there is a much higher prevalence of complications when compared with insured patients with newly diagnosed type 2 diabetes.

How might these results change the focus of research or clinical practice?

- The changing landscape of health insurance in the USA may result in less coverage especially for minority populations resulting in higher risks of complications at the time of diagnosis of diabetes.

INTRODUCTION

Type 2 diabetes is a fast-growing worldwide epidemic.[1] Silent hyperglycemia can be present for years prior to diagnosis,[2] leading to the existence of microvascular and macrovascular complications at the time of initial presentation. It is estimated that up to a third of people with diabetes are undiagnosed, with the hypothesized lag time between its onset and diagnosis averaging 4 years to 7 years.[3 4] In the UK Prospective Diabetes Study (UKPDS), which examined the long-term effect of intensified therapy on the development of diabetes comorbidities, several diabetes-related complications were already present at the time of diagnosis with 36% affected by retinopathy, the leading complication.[5]

Diabetes complications are progressive and can lead to significant morbidity and mortality. In the USA, diabetes is a leading cause of end-stage renal disease.[6] Diabetes-related autonomic neuropathy is the incriminated factor in increased cardiovascular mortality in the setting of nocturnal hypoglycemia.[7 8] One can therefore assume that patients who are presenting at the time of diagnosis with complications are at higher risk to have worse progression of these complications over time.[9 10]

Type 2 diabetes is more prevalent in the USA in underserved minority populations, like Hispanic and non-Hispanic blacks, as compared with non-Hispanic whites.[11] These patients may face obstacles to obtaining early diagnosis and subsequent care of diabetes. Obstacles include limited access to care, high

rate of unemployment with subsequent low income and lack of insurance, social challenges, and limited access to transportation.[12–14]

In this study, we aimed to assess the clinical presentation and prevalence of diabetes complications in underserved minority patients in a large urban area at the time of initial diagnosis of type 2 diabetes and compare results to other studies that assessed the same outcomes: a diverse population in South London, UK[15] and an insured population in Portland, Oregon, USA.[16]

RESEARCH DESIGN AND METHODS

Study design

This is a retrospective cross-sectional study of patients in an underserved ethnic minority adult population in Chicago newly diagnosed with type 2 diabetes between 2003 and 2013. Data were collected by electronic chart review of 2280 adult patients who were newly diagnosed with type 2 diabetes and referred to our diabetes clinic within 1 year of diagnosis. The diabetes clinic is an American Diabetes Association (ADA)-certified diabetes center in John H. Stroger, Jr. Hospital of Cook County, a public safety-net healthcare system in Chicago, Illinois, USA.

Eligibility criteria

Inclusion criteria included adult patients (age ≥18 years) who were newly diagnosed with type 2 diabetes and referred to our diabetes clinic within 1 year of diagnosis. Diagnosis of type 2 diabetes was confirmed following ADA guidelines with at least two instances of glycosylated hemoglobin A_{1c} (HbA_{1c}) ≥6.5% (48 mmol/mol) (preferred method), documented fasting blood glucose ≥126 mg/dL, or one instance of symptomatic hyperglycemia with documented blood glucose >200 mg/dL.[17] Exclusion criteria included pediatric patients (age <18 years), initial evaluation in our clinic after 1 year of diagnosis or unclear time of diagnosis, type 1 diabetes, or latent autoimmune diabetes in adults, or absence of HbA_{1c}.

Data collection

The electronic database for our diabetes clinic was initiated in 2003 and collected demographic, clinical, laboratory, and treatment data. It also included the date of diabetes diagnosis that was identified at initial encounter when the diagnosis was made or by patient recall. Records of 22,333 patients were screened, adult patients (age ≥18 years old) who were seen in our diabetes clinic within 1 year of diagnosis were identified, and 2280 patients met the inclusion criteria as shown in the Consolidated Standards of Reporting Trials diagram in figure 1.

Demographic data included age at diagnosis, employment, marital status, and insurance status. Spoken languages, ethnicity, and psychological concerns were recorded. Vital signs and laboratory results were collected. Microvascular and macrovascular complications and hypertension were all documented at presentation. Microvascular complications included nephropathy, neuropathy, and retinopathy. Macrovascular complications included coronary artery disease (CAD), congestive heart failure (CHF), peripheral vascular disease (PVD), and cerebrovascular accidents (CVA). Nephropathy included albuminuria ≥30 mg/g creatinine and/or estimated glomerular filtration rate ≤60 mL/min/1.73 m^2. Neuropathy included reported subjective tingling and/or numbness in extremities, and/or decreased monofilament sensation on physical exam. Retinopathy was indicated by positive formal ophthalmologic retinal exam or if the patient reported having retinopathy by recall after ophthalmologic evaluation outside of our institution. Presence of CAD was indicated by a positive stress test, history of coronary artery stenting or coronary artery bypass grafting (CABG), or history of prior heart attacks. CHF was confirmed by prior echocardiogram or by clinical diagnosis of heart failure. PVD was confirmed by vascular studies. CVA was confirmed by prior diagnosis of transient ischemic attacks or stroke. Hypertension was defined as systolic blood pressure ≥140 mm Hg and/or diastolic blood pressure ≥90 mm Hg or use of hypertensive medications.[18]

Study outcomes

The main outcome was evaluation of diabetes-related complications at the time of clinical diagnosis of diabetes. Secondary outcomes included identification of the demographic and clinical factors associated with the development of these complications as well as comparing our study group to those newly diagnosed with type 2 diabetes in two other clinical and socioeconomic settings: a diverse population in south London[15] and insured patients in Portland, Oregon.[16]

Statistical analysis

The data were stored in a secure server of John H. Stroger Jr. Hospital of Cook County, Chicago, Illinois, USA. Data were electronically transferred to SPSS (Statistical Package for the Social Sciences) for statistical analysis. All statistical analyses were performed with SPSS, V.22 (SPSS, Chicago, Illinois, USA). Categorical data are presented as percentages and absolute numbers (n), continuous data are presented as means±SD for normally distributed values and by medians and IQRs for non-normally distributed data. The χ^2 test was used for analysis of categorical variables and t-test was used for continuous variables. For multivariable analysis, binary logistic regression was used.

To compare data between the three groups (Chicago, South London, and Portland), a fixed-effects statistical model for meta-analysis was used.[19] The means, SD, and proportions were weighted based on the sample sizes of the different cohorts in each study. The CIs for the Chicago cohort variables were calculated for the p values of 0.05, 0.01, and 0.001. These were compared with corresponding means and proportions in the two other cohorts to determine the statistical significance.[19]

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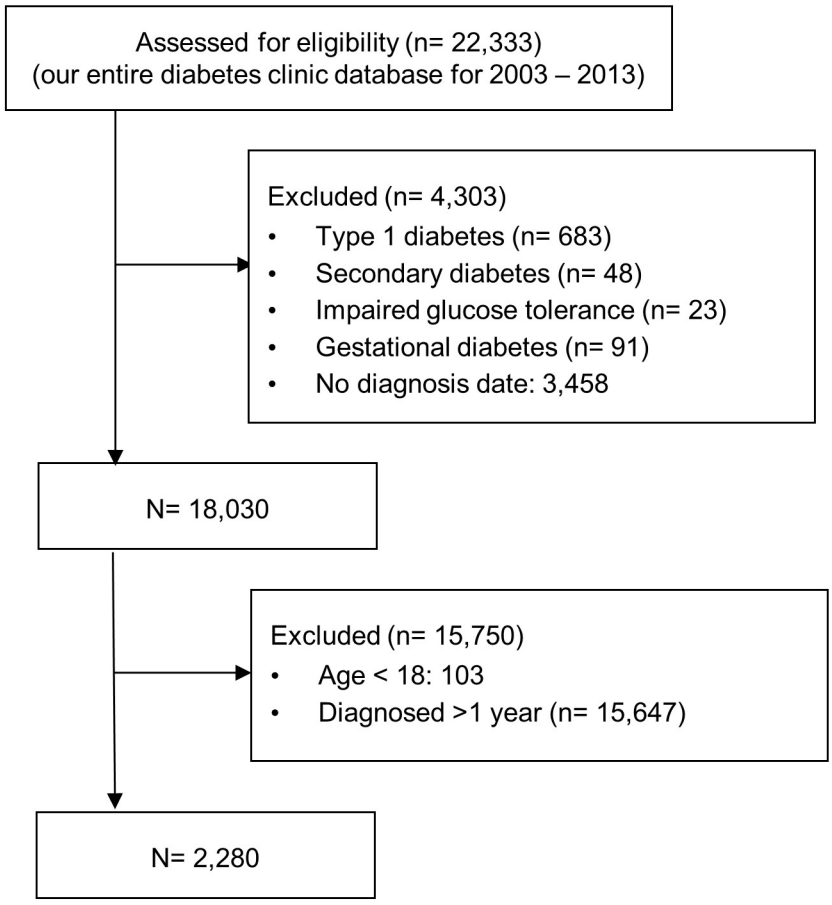

Figure 1 Consolidated Standards of Reporting Trials (CONSORT) diagram.

RESULTS

Demographics and baseline characteristics of our Chicago cohort are shown in table 1. Most were African-American (48.1%) or Hispanic (32.5%), unemployed (69.9%), and 28.4% were non-English speakers. Mean body mass index (BMI) was 32.8±7.4 kg/m^2 and 58.4% of the patients had Hb_{A1c}>9.0% (75 mmol/mol). The complication rates at presentations of our Chicago cohort are shown in table 2. Microvascular complications were present in 50.1%, including retinopathy in 10.7%, nephropathy in 22.2%, and neuropathy in 27.7%. Hypertension was present in 69.4%. Macrovascular complications were present in 13.4% including CAD in 4.3%, CHF in 3.3%, PVD in 4.1%, and CVA in 1.9%.

The factors associated with microvascular and/or macrovascular complications in our Chicago cohort are shown in figure 2. Microvascular complications correlated significantly with dyslipidemia (OR 1.47 (95% CI 1.15 to 1.89), p<0.01), hypertension (OR 1.35 (95% CI 1.09 to 1.67), p<0.01), older age (OR 1.02 (95% CI 1.01 to 1.03), p<0.01), and inversely with exercise (OR 0.72 (95% CI 0.58 to 0.90), p<0.01). Macrovascular complications correlated significantly with dyslipidemia (OR 3.23 (95% CI 2.38, 4.37), p<0.01), hypertension (OR 2.53 (95% CI 1.64 to 3.90), p<0.01), being insured (OR 1.95 (95% CI 1.29 to 2.96), p<0.01), male gender (OR 1.58 (95% CI 1.16 to 2.14), p<0.01), smoking (OR 1.56 (95% CI 1.16 to 2.08), p<0.01), older age (OR 1.05 (95% CI 1.03 to 1.07), p<0.01), and elevated BMI (OR 1.02 (95% CI 1.01 to 1.04), p=0.03). Both microvascular and macrovascular complications (composite outcome) correlated significantly with dyslipidemia (OR 1.73 (95% CI 1.30 to 2.29), p<0.01), being insured (OR 1.75 (95% CI 1.16 to 2.62), p<0.01), hypertension (OR 1.43 (95% CI 1.14 to 1.80), p<0.01), being English-speaker (OR 1.35 (95% CI 1.06 to 1.72), p=0.02), older age (OR 1.02 (95% CI 1.01 to 1.03), p<0.01), TG/HDL (triglycerides/high-density lipoprotein) ratio (OR 1.02 (95% CI 1.01 to 1.05), p=0.02), and inversely with exercise (OR 0.66 (95% CI 0.52 to 0.87), p<0.01). HbA_{1c} at initial presentation, ethnicity, employment status, and marital status were not associated with any complications.

The comparison of our Chicago cohort to those newly diagnosed with type 2 diabetes in the other two cohorts—an urban nationally insured population from primary care practices in South London and a managed care population, 90% non-Hispanic whites, in Portland, Oregon[16]is shown in table 2. The Chicago cohort was younger (49.0 vs 55.4 and 55.7 years, respectively, p<0.001) and had worse HbA_{1c} at presentation (10.0% (86 mmol/

Table 1 Demographics and baseline characteristics of the Chicago cohort

Patient population (n)	2280
Mean age (years)	49.0±11.3
Gender (%)	
Male	54.4
Female	45.6
Marital status (%)	
Single	41.8
Married	31.6
Divorced	9.9
Separated	5.9
Widowed	5.6
Others	5.2
Employment status (%)	
Unemployed	69.9
Full-time	11.6
Part-time	11.4
Retired	0.6
Others	6.5
History of smoking (%)	54.4
Ethnicity (%)	
African-American	48.1
Hispanic	32.5
Caucasian	9.7
Asian-Pacific	6.2
African	2.1
Others	1.4
Primary language (%)	
English	64.5
Spanish	21.2
English and Spanish	7.1
Polish	2.2
Others	5.0
Family history of diabetes (%)	
Positive	67.1
Negative	32.9
Insurance status (%)	
Uninsured	82.2
Insured	17.8
BMI (kg/m^2)	32.8±7.4
Waist circumference (cm)	
Men	109.7±20.8
Women	108.5±22.9
Hypertension (%)	69.4
Systolic blood pressure (mm Hg)	130±19.9
Diastolic blood pressure (mm Hg)	74±11.7
HbA_{1c} at diagnosis (%)	10.0±2.9
HbA_{1c} at diagnosis (mmol/mol)	86±32
HbA_{1c} <7% (53 mmol/mol)	16.8%
HbA_{1c} 7%–9% (53–75 mmol/mol)	24.8%
HbA_{1c} >9% (75 mmol/mol)	58.4%
Total cholesterol (mg/dL)	176 (IQR 149–206)
Low-density lipoprotein (mg/dL)	99 (IQR 78–126)
High-density lipoprotein (mg/dL)	
Men	40 (IQR 34–47)
Women	47 (IQR 40–55)
Triglycerides (mg/dL)	129 (IQR 90–193)
Albumin/creatinine ratio (mg/g creatinine)	9.1 (IQR 4.5–113.4)
Microalbuminuria (30–300 mg/g) (moderately increased albuminuria)	16.2%
Macroalbuminuria (>300 mg/g) (severely increased albuminuria)	3.7%
eGFR (mL/min/1.73 m^2)	102.7 (IQR 84.3–120.9)
CKD 3a (eGFR 45–59)	2.9%
CKD 3b (eGFR 30–44)	0.8%

BMI, body mass index; CKD, chronic kidney disease; HbA1c, hemoglobin A1c; eGFR, estimated glomerular filtration rate.

mol) vs 8.2% (66 mmol/mol) and 6.6% (49 mmol/mol), respectively, p<0.001). The microvascular complications in the Chicago cohort were significantly higher than in the other two cohorts especially nephropathy (22.2% vs 16.7% and 5.7%, p<0.001) and retinopathy (10.7% vs 7.9% and 1.4%, p<0.001). The composite macrovascular complications were comparable between the Chicago and Portland cohorts. However, the Portland cohort had a higher CAD rate compared with the Chicago cohort (11.2% vs 7.6%, P<0.001).

CONCLUSIONS

This is the first study that shows rates of diabetes complications at initial presentation in an underserved, low-income urban minority population and compares it with other cohorts from different social settings. In this study, the Chicago cohort presents with many of the social and financial impediments known to impact diabetes and its complications. Most of our patients were unemployed, uninsured, and almost a third were not English-speakers. Hyperglycemia at initial presentation was severe with almost 60% with HbA_{1c}>9% (75 mmol/mol). The rate of complications, especially microvascular, was very high and comparable only to the UKPDS Study in Great Britain that was conducted in the 1980s when the retinopathy

Table 2 Diabetes complications at presentation in different studies

Study location and year of publication	Chicago 2018	South London 2015	Portland 2003	P Values
Studied years	2003–2013	2012–2013	1996–1998	
Number of patients	2280	1149	7844	
Insurance status	Underinsured	NHS	Managed care	<0.001*
Age criteria	49.0±11.3	55.7±10.9	55.4±9.4	<0.001*†
Average HbA_{1c}, %	10.0±2.9	6.6±0.3	8.2±2.2	<0.001*†
Average HbA_{1c}, mmol/mol	86±32	49±3	61±29	<0.001*†
Retinopathy	10.70%	7.86%	1.40%	<0.001*†
Nephropathy	22.20%	16.68%	5.70%	<0.001*†
Neuropathy	27.70%	6.65%	N/A	<0.001†
Microvascular complications composite	50.10%	N/A	5.90%	<0.001*†
CAD	7.60%	4.81%	11.2%	<0.001*†
CVA	1.90%	3.5%	3%	<0.001*†
PVD	4.10%	N/A	1.70%	<0.001*†
Macrovascular complications composite	13.40%	N/A	13.20%	NS

Mean age and average HbA_{1c} were based on weighing the number of patients in different study cohorts and their corresponding variance. Studies were weighted based on the absolute numbers (n). Independent sample t-test was used for comparison and for calculating p values.
*Indicates significant p value between the Chicago and Portland studies.
†Indicates significant p value between the Chicago and South London studies.
CAD, coronary artery disease; CVA, cardiovascular accident; HbA1c, hemoglobin A1c; NHS, National Health Service; PVD, peripheral vascular disease.

was 21%, abnormal vibration threshold (neuropathy), 51%, plasma creatinine >120 µmol/L 52%, myocardial infarction 34%, cerebrovascular events 38%.[20] The high rate of complications that are present at diagnosis in this cohort can result in higher diabetes morbidity in the long term. Other studies showed that long-term complications are much higher and more severe in the minorities especially in the development of end-stage renal failure and amputations.[21–23]

When compared with the two other cohorts, the South London[15] and Portland,[16] the Chicago cohort had much worse glycemic control and complications. The insurance status and ethnic composition of these two cohorts differed in comparison to the Chicago cohort. The South London patients were ethnically 50.1% white, 39.6% black, and 10.3% South Asian/other and had medical coverage through the National Health Service. In the Portland cohort, 90% of the patients were white and had managed care medical coverage. Half of the patients in the Chicago cohort had microvascular complications at diagnosis similar only to the UKPDS Study where half the patients presented with at least one complication.[20]

The prevalence of composite macrovascular complications, however, were similar between the Chicago and Portland cohorts (no data in the South London cohort). The prevalence of CAD was higher in the Portland cohort versus the Chicago cohort. This difference may be explained by the significantly older age at diagnosis in the Portland cohort. This is further supported by the Portland study itself which showed those diagnosed at a younger age (<45 years) had lower rates of myocardial infarction history than those diagnosed at an older age (0.8% vs 13%).

The strikingly high rate of complications and the poor glycemic control at presentation in the Chicago cohort in comparison to the two other cohorts needs an explanation. The differences in the ethnic composition of the cohort may be one. It is known that diabetic nephropathy is more common in African-Americans that comprised almost half of the cohort.[21] However, the most important and plausible explanation for these differences is the different socioeconomic settings of the cohorts and above all the lack or insufficient medical insurance coverage of the Chicago cohort. The importance of medical coverage in achieving better health outcomes is well proven.[24] This has also been seen in diabetes where health disparities in underinsured minorities resulted in worse diabetes outcomes.[25] The comparison cohorts had medical insurance, the South London cohort through the National Health Service and the Portland cohort through managed care. The Chicago cohort was primarily uninsured and both the US cohorts dealt with patients diagnosed prior to the implementation of the Affordable Care Act (also known as 'Obama Care') in 2014.

The presence of microvascular complications in the Chicago cohort was associated with dyslipidemia, hypertension, being more sedentary, and with older age in a minimal degree. There was no association with HbA_{1c}

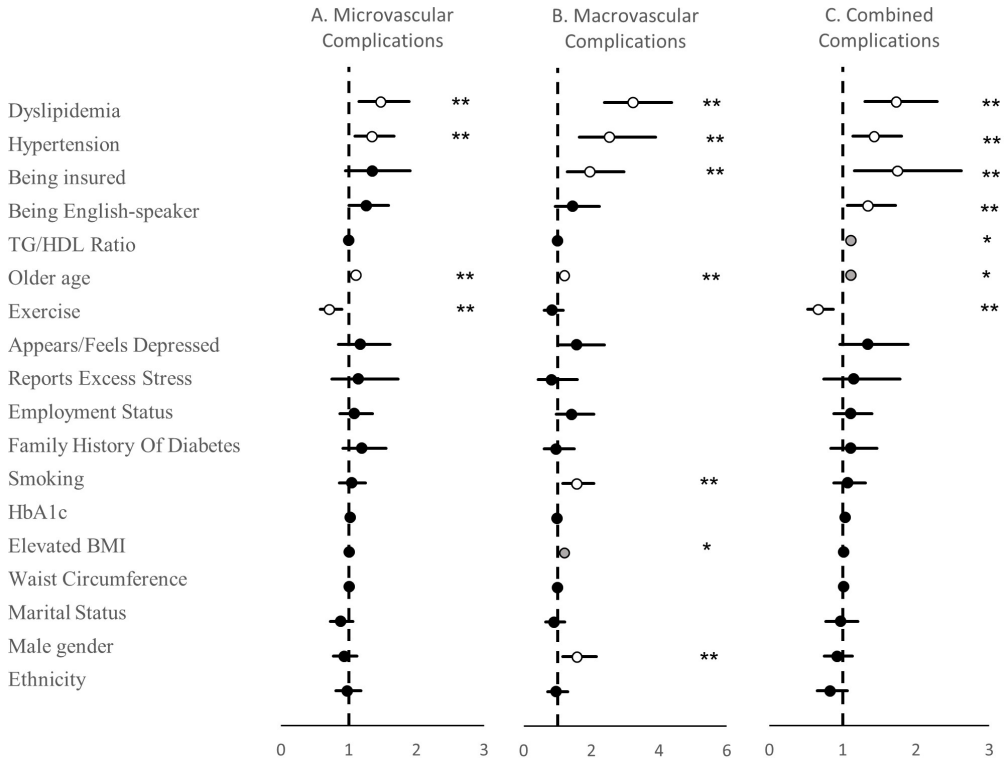

Figure 2 Factors correlated to type 2 diabetes-related complications on presentation in the Chicago cohort. OR (95% CI) for the factors correlated with diabetes-related complications at the time of initial diagnosis. Figure (A) represents correlation with microvascular complications, figure (B) represents correlation with macrovascular complications, and figure (C) represents correlation with the presence of both macrovascular and microvascular complications. **p<0.01 represented in white-filled circles; *p 0.01–0.05 represented in grey-filled circles; and p>0.05 represented in black-filled circles.BMI, body mass index; HbA1c,hemoglobin A1c; TG/HDL, triglycerides/high-density lipoprotein.

at presentation. The macrovascular complications were associated with dyslipidemia, hypertension, older age, smoking, excess stress and being male. It is less clear why having insurance was associated with the macrovascular complications. It was also associated with the composite outcome of microvascular and macrovascular complications. One explanation might be that presence of the complications in an insured setting prompted the diagnosis of new diabetes. The combined complications were associated with dyslipidemia, hypertension, being insured, older age, TG/HDL ratio, and lower exercise level. Being English-speaking was also associated with the combined complications and this association is not easy to explain. TG/HDL was shown in previous studies to be an atherogenic index and correlated with atherosclerosis.[26] Taken together, the analysis of the factors that might have influenced the silent development of complications in the Chicago cohort did not give any special insight. Like in the Portland cohort, older age was associated with complications but to a much lesser degree.

This retrospective study has several limitations. As a retrospective study, some of the data were based on patient history and not on objective provider documentation or testing. Since the study was based on past medical documentation, additional information not gathered in the documentation, such as assessments on health literacy, food security, and other possible covariates, could not be obtained. Retinopathy in many instances was based on history provided by patients that they were informed about having retinopathy with no documentation or specific diagnosis available to the providers. Assessment of depression or anxiety was subjective, based on provider history-taking and without the use of formal psychological tools for assessment. The study population came from a single healthcare system limiting generalizability yet this large healthcare system with its multiple clinic sites treats patients from a diverse metropolitan region encompassing the city of Chicago and its surrounding communities.

In conclusion, the Chicago cohort study showed for the first time the pattern of clinical presentation of newly diagnosed type 2 diabetes in an underinsured urban minority population. In comparison to other cohorts with different ethnic compositions and above all with better medical insurance coverage, the Chicago cohort showed an alarming rate of diabetes complications already at the initial diagnosis of diabetes. The high prevelance of diabetes complications at the initial diagnosis may be a precondition, in this cohort and in other similarly underinsured minority populations, worse progression of diabetes and its disabling microvascular and macrovascular hard outcomes. All the data of the Chicago cohort

represent a period before the enactment of the Affordable Care Act in 2014. The importance of this study is the demonstration that for the uninsured/underinsured population there is, from the very beginning of the clinical diagnosis of diabetes, a high rate of complications. In the current era of uncertainty about the future of extending medical coverage to economically weaker populations and even with the risk that the current coverage could be reduced, the current study illustrates the potential diabetes health risks if more patients will continue to be uninsured.

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