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BRIEF REPORT

Change in Diabetes Prevalence and Control among New York City Adults: NYC Health and Nutrition Examination Surveys 2004–2014

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Abstract National examination surveys provide trend information on diabetes prevalence, diagnoses, and control. Few localities have access to such information. Using a similar design as the National Health and Nutrition Examination Survey (NHANES), two NYC Health and Nutrition Examination Surveys (NYC HANES) were conducted over a decade, recruiting adults ≥ 20 years using household probability samples ($n = 1808$ in 2004; $n = 1246$ in 2013–2014) and physical exam survey methods benchmarked against NHANES. Participants had diagnosed diabetes if told by a health provider they had diabetes, and undiagnosed diabetes if they had no diagnosis but a fasting plasma glucose ≥ 126 mg/dl or A1C ≥ 6.5%. We found that between 2004 and 2014, total diabetes prevalence (diagnosed and undiagnosed) in NYC increased from 13.4 to 16.0% ($P = 0.089$). In 2013–2014, racial/ethnic disparities in diabetes burden had widened; diabetes was highest among Asians (24.6%), and prevalence was significantly lower among non-Hispanic white adults (7.7%) compared to that among other racial/ethnic groups ($P < 0.001$). Among adults with diabetes, the proportion of cases diagnosed increased from 68.3 to 77.3% ($P = 0.234$), and diagnosed cases with very poor control (A1C > 9%), decreased from 26.9 to 18.0% ($P = 0.269$), though both were non-significant. While local racial/ethnic disparities in diabetes prevalence persist, findings suggest modest improvements in diabetes diagnosis and management.

Keywords Diabetes · Control diabetes · Biomonitoring · Health inequalities

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Introduction

In the past 20 years, the burden of diabetes in the USA has grown substantially [1, 2]. National efforts to reduce burden, improve detection, and manage diabetes have yet to curb growing incidence and prevalence but have resulted in modest improvements in diabetes diagnosis and control of risk factors such as hemoglobin A1C (A1C), blood pressure, and cholesterol [1–5].

To address the diabetes epidemic, local-level diabetes prevention and control initiatives have been mounted across the country [6]. Unfortunately, few localities have adequate data sources to monitor progress beyond statewide self-reported diabetes prevalence. Beginning in 2002, the New York City (NYC) Department of Health and Mental Hygiene (DOHMH) expanded its surveillance capacity to monitor diabetes prevalence and

control, with an aim to guide decision-making regarding municipal initiatives to address diabetes and evaluate progress achieved [4, 5, 7, 8]. This included conducting representative surveys and establishing mandatory laboratory reporting of A1C test results for NYC residents to the DOHMH [9]. The agency collected self-reported diabetes prevalence information from annual large random-digit-dialed cross-sectional telephone surveys of adults, modeled on the national Behavioral Risk Factor Surveillance System, to provide robust data at the citywide and neighborhood levels. As part of this expanded surveillance portfolio, the DOHMH also developed and launched the NYC Health and Nutrition Examination Survey (NYC HANES) in 2004 and then, with an academic partner, repeated the survey 10 years later. NYC HANES included a detailed health interview, brief physical exam, and biologic sample collection. In this brief, we examine change in (a) the percentage of NYC adults with diagnosed and undiagnosed diabetes, (b) the proportion diagnosed, and (c) the proportion under glycemic control, and we contrast findings to national trends from the same time period.

Research Design and Methods

Survey Design

NYC HANES is a population-based cross-sectional survey modeled on NHANES, designed to assess the health of New Yorkers, identify health problems, and support evaluation of interventions in NYC. Methods of the 2004 and 2013–2014 surveys have been previously published in detail [10, 11]. For both surveys, a three-stage cluster sampling design was used to select a representative sample of non-institutionalized NYC residents aged 20 years or older. Data collection included face-to-face computer-assisted interviews, physical examination, and biologic specimen collection. Standardized NHANES protocols and testing laboratories were used for most measures, except where specified otherwise.

Definitions

Participants were identified as having diagnosed diabetes if they reported having ever been told by a health care professional that they have diabetes. Undiagnosed diabetes was defined as having a fasting plasma glucose (FPG) of 126 mg/dl or higher or an A1C level of 6.5% (48 mmol/mol) or higher among those reporting no previous diagnosis of diabetes [12]. Total diabetes was defined as the sum of diagnosed and undiagnosed diabetes. Cut-points to assess control of A1C were based on treatment targets from the 2013 American Diabetes Association (ADA) Standards of Care [12].

Data Analyses

For each survey year, we calculated diabetes prevalence and the proportion of adults with diabetes who were diagnosed and the percent change over time. To estimate the proportion diagnosed versus undiagnosed, we included participants with a valid response to the question of whether they had ever been diagnosed with diabetes and a valid measure of either FPG or A1C. For diabetes management indicators, we included all participants with diagnosed diabetes who had a valid A1C measure and calculated the proportion meeting ADA treatment goals in 2004 and 2014 and percent change over time. National data from 2001 to 2004 and 2011 to 2014 NHANES were also analyzed to calculate the prevalence of total diabetes, proportion of diagnosed diabetes, and proportion of controlled diabetes among US adults.

Data were weighted to account for complex survey design and non-response, and adjusted for missing data. SAS 9.4 (Cary NC) and SUDAAN 10.0 (NC) were used for analyses. We used chi-square tests to assess univariate associations and multivariable regression for adjusted analyses. *t* tests were used to examine statistical significance of change over time using "t_pct" in a "proc descript" statement with a contrast between the two survey years [13].

Results

Table 1 provides the demographic distribution of adults in NYC with diagnosed and undiagnosed diabetes (total diabetes). Between 2004 and 2014, the age-standardized prevalence of total diabetes among NYC adults increased from 13.4 to 16.0% ($P = 0.089$). In 2013–2014, diabetes prevalence was significantly elevated among adults with lower education, lower income, adults born outside of the USA, and those with a higher body mass index (BMI) ($P < 0.05$). Diabetes prevalence was the highest among non-Hispanic Asian adults (24.6%), followed by non-Hispanic Black (21.6%) and

Table 1 Diabetes prevalence among NYC adults aged 20 and older by demographic characteristics, NYC HANES 2004 and 2013–2014

	2004					2013–2014					% change for total diabetes	
	Total sample		Total diabetes †			Total sample		Total diabetes †				
Characteristics	*N*	%	*N*	%	95% CI	*N*	%	*N*	%	95% CI	Change¥	*P* value
Total	1808	–	190	13.4	11.4–15.7	1246	–	192	16.0	14.0–18.3	19.4	0.089
Age group												
20–44^	1107	53.0	43	5.9	4.2–8.2	654	51.0	26	6.4	3.9–10.1	8.5	0.817
45–64	542	31.7	88	16.1***	12.2–20.8	415	32.5	103	23.6	19.3–28.6	46.6	0.018
≥65	159	15.4	59	37.3***	28.4–47.2	177	16.4	63	34.6	27.3–42.7	−7.2	0.663
Gender												
Male^	764	46.1	86	13.7	11.1–16.9	523	46.6	81	15.8	12.9–19.2	15.3	0.363
Female	1044	53.9	104	13.3	10.8–16.4	723	53.4	111	16.2	13.4–19.4	21.8	0.168
Race												
Non-Hispanic White^	536	38.1	47	10.8	8.1–14.3	435	35.0	34	7.7	5.5–10.8	−28.7	0.140
Non-Hispanic Black	386	23.1	55	16.5**	12.2–22.0	262	21.3	54	21.6***	16.9–27.2	30.9	0.157
Hispanic	629	26.1	54	12.4	9.3–16.4	325	27.1	65	19.4***	15.7–23.7	56.5	0.011
Asian	229	10.9	31	19.8**	13.5–28.1	162	14.0	30	24.6***	17.9–32.9	24.2	0.360
Education												
Less than high school	521	26.8	95	20.7***	17.2–24.7	260	18.9	71	21.9***	18.0–26.4	5.8	0.655
Completed high school	350	19.1	34	12.3	8.9–16.8	189	22.9	34	16.4	12.1–22.1	33.3	0.194
More than high school^	934	54.1	60	9.3	7.1–12.1	795	58.2	86	12.6	9.9–15.9	35.5	0.108
Income												
Less than $20,000	616	32.5	94	18.7***	15.5–22.3	337	29.2	75	20.2*	16.7–24.2	8.0	0.545
$20,000 or more^	1153	67.5	89	10.1	7.7–13.1	833	70.8	98	13.5	10.9–16.6	33.7	0.088
Neighborhood poverty level												
0 to <10% (Low poverty)^	438	27.8	38	10.5	7.3–14.8	335	26.7	53	16.1	12.8–20.1	53.3	0.042
10 to <20%	514	32.5	48	12.0	9.0–15.7	427	33.0	52	12.7	9.7–16.4	5.8	0.756
20 to <30%	244	12.5	30	14.5	8.8–23.0	269	21.4	37	14.8	10.0–21.4	2.1	0.958
30–100%	612	27.2	74	17.7**	13.9–22.2	215	18.9	50	22.9*	18.9–27.5	29.4	0.081
Country of birth												
US born^	883	51.7	89	12.6	9.9–15.8	707	54.9	78	12.3	9.8–15.5	−2.4	0.913
Non-US born	923	48.3	101	14.4	11.5–17.9	534	45.1	113	19.9***	16.9–23.3	38.2	0.018
BMI												
<25^	719	38.8	34	6.9	4.7–10.0	450	34.7	26	8.7	5.9–12.6	26.1	0.413
25–29	619	35.3	67	13.2**	10.2–16.9	420	34.9	72	15.8**	12.3–20.2	19.7	0.318
≥30	462	25.9	86	20.5***	16.9–24.6	359	30.5	86	21.0***	17.4–25.1	2.4	0.838

All estimates were age standardized to the 2000 US population

† Diabetes was defined by FPG ≥ 126 mg/dl or A1C ≥ 6. 5% (48mmol/mol) or previous diagnosis

^ Referent category

¥ Relative percent change was calculated by dividing the amount of observed change between the survey years by the 2004 value

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$

Hispanic (19.4%) adults, each of which was higher than prevalence measured among non-Hispanic White adults (7.7%) ($P < 0.001$). Over the 10-year time period, prevalence significantly increased among adults aged 45–64 years, Hispanic adults, adults born outside the USA, and adults living in wealthier neighborhoods ($P <$

Table 2 Changes in diabetes estimates, treatment, and control among US and NYC adults aged 20 years and older, NHANES 2001–2004 and 2011–2014 and NYC HANES 2004 and 2013–2014

	NYC HANES				NHANES			
	2004 (%)	2013–2014 (%)	% change¥	*P* value	2001–2004 (%)	2011–2014 (%)	% change¥	*P* value
Total diabetes prevalence†	13.4	16.0	19.4	0.089	10.5	12.3	17.1	0.006
Proportion diagnosed‡	68.3	77.3	13.2	0.234	71.7	70.8	− 1.3	0.791
Proportion with A1C > 9% [75 mmol/mol]∞	26.9	18.0	− 33.1	0.269	19.1	19.5	2.1	0.929
Proportion controlled (A1C < 7% [53 mmol/mol])∞	42.2	51.3	21.6	0.336	47.6	47.7	0.2	0.982
Diabetes medication use∞€								
Insulin	15.4	36.1	135.1	0.022	28.0	33.3	18.9	0.192
Pills only (non-insulin)	61.0	54.9	− 10.0	0.509	53.1	46.7	− 12.1	0.085
No medication	23.6	8.6	− 62.3	0.023	18.9	20.0	5.8	0.755

All estimates were age-standardized to the 2000 US population

† Diabetes was defined by FPG ≥ 126 mg/dl or A1C ≥ 6.5% (48 mmol/mol) or previous diagnosis

‡ Only adults with valid FPG and/or A1C measures were included to calculate proportion diagnosed diabetes

¥ Relative percent change was calculated by dividing the amount of observed change between the survey years by the 2004 value

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$

∞ Estimate is measured among adults with diagnosed diabetes only

€ One participant in 2013–2014 reported using non-insulin injectable diabetes medication only (0.3%), a category not asked in 2004

0.05). In contrast to other demographic groups, the data suggest that non-Hispanic White adults experienced a decrease in total diabetes prevalence (Table 1).

Between 2004 and 2013–2014, the proportion of NYC adults with diabetes who had their condition diagnosed went from 68.3 to 77.3%, a non-significant increase ($P = 0.234$) (Table 2). Significant diagnosis improvements were observed among adults aged 65 years or older (from 68.1 to 84.4%, $P = 0.029$) and Hispanic adults (from 59.8 to 87.8, $P < 0.0001$). In analyses restricted to NYC adults with diagnosed diabetes only, we observed non-significant reductions in A1C levels: the proportion of adults with very poor control (A1C > 9%) decreased by 33.1% over the two time periods, from 26.9 to 18.0% ($P = 0.269$); and the proportion with an A1C < 7% increased from 42.2% in 2004 to 51.3% in 2013–2014 ($P = 0.336$). Mean A1C was 7.8% in 2004 and 7.4% in 2013–2014, ($P = 0.264$). Among those with A1C > 9% (75 mmol/mol), only 26.2% used insulin in 2004 as compared to 55.2% in 2013–2014 ($P = 0.066$). Table 2 also contrasts changes in NYC diabetes estimates with national data for a comparable timeframe (2001–2004 to 2011–2014).

Nationally, the magnitude of increase in prevalence of total diabetes (17%, $P = 0.006$) was comparable to that observed in NYC, yet national changes in proportion diagnosed and proportion controlled were negligible (1.3% decrease and 0.2% increase, respectively). Likewise, there was a non-significant increase in adults with diagnosed diabetes whose A1C was > 9% nationally ($P = 0.815$). In 2004, the proportion of adults with diagnosed diabetes who reported insulin use in NYC was substantially lower than national estimates (15.4 vs 28%). By 2013–2014, insulin use in NYC rose to a level comparable with that in the nation.

Conclusions

Using objective measures from two population-based studies of NYC adults 10 years apart, we observed a modest increase in overall diabetes prevalence among NYC adults from 2004 to 2013–2014, similar in magnitude to national trends. Overall, we estimated that 16.0% of NYC adults aged 20 years or older had either diagnosed or undiagnosed diabetes in 2013–2014,

representing an estimated 819,000 and 169,000 adult residents, respectively. Findings demonstrate that racial/ethnic disparities in diabetes burden persist and appear to have widened in NYC, with 2013–2014 data demonstrating a twofold disparity between Whites and other groups. Asians had the highest prevalence of diabetes among all racial/ethnic groups in NYC, mirroring previous findings suggesting higher risk of diabetes among this group, even at a lower BMI [14]. However, the observed temporal increase in diabetes prevalence was largest among Hispanic adults. Findings also suggest that the city has experienced modest improvements in diabetes diagnosis in some subgroups, and insulin use increased dramatically between the two time periods, now matching the national rate. Notably, no improvements in diagnosing diabetes or glycemic control were made at the national level in the past decade, after a sustained period of improvement between 1988 and 2006 [3, 4]. These local findings are slightly more optimistic than trends previously observed using data from the NYC A1C Registry, which suggested no change in mean A1C between 2006 and 2012 or the proportion with an A1C < 7% [15]. However, the NYC A1C Registry includes data from inpatient care and institutionalized settings; thus, the two data sources are not directly comparable.

This study had several limitations. First, this analysis was based on cross-sectional data and we cannot formally investigate the causes for observed trends. Second, our NYC HANES analyses were limited in statistical power, resulting in less precise estimates and some observed changes that were statistically non-significant and which may be due to chance. Limited statistical power also hampered our ability to detect patterns of change in diagnosing and controlling diabetes by the racial/ethnic subgroup.

Strengths of this analysis include having unprecedented population-based examination and biomeasures for a local municipality, representing non-institutionalized NYC adults and statistically accounting for sampling and non-response bias in analyses. Formal benchmarking of questionnaires, biomeasure collection, and laboratory testing against NHANES allows for comparison to nationally representative data long recognized as providing definitive information about diabetes trends over time.

In conclusion, our findings provide the first locally representative snapshot of overall diabetes burden, awareness, and control over time. While some progress on improvement in care was observed and may have resulted from municipal and clinically focused interventions to improve detection and management of diabetes, the overall diabetes burden is high and racial/ethnic disparities in prevalence are not improving. A wide array of diabetes prevention and management initiatives have been underway for several years and residents have access to a large number of academic hospital systems, yet numerous economic and environmental stressors persist, including lack of access to affordable, healthy food, challenging work schedules, and insufficient opportunities to engage in physical activity. Continued monitoring of the cascade of care continuum by race/ethnicity is critical to address and reverse disparities.

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