



Rationale, design and respondent characteristics of the 2013–2014 New York City Health and Nutrition Examination Survey (NYC HANES 2013–2014)

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ABSTRACT

Purpose. Capacity to monitor non-communicable diseases (NCDs) at state or local levels is limited. Emerging approaches include using biometrics and electronic health record (EHR) data. In 2004, New York City (NYC) performed a population-based health study on adult residents using biometrics (NYC Health and Nutrition Examination Study, or NYC HANES), modeled after NHANES. A second NYC HANES was launched in 2013 to examine change over time, evaluate municipal policies, and validate a proposed EHR-based surveillance system. We describe the rationale and methods of NYC HANES 2013–2014.

Methods. NYC HANES was a population-based, cross-sectional survey of NYC adults using three-stage cluster sampling. Between August 2013 and June 2014, selected participants completed a health interview and physical exam (blood pressure, body mass index, and waist circumference). Fasting biometrics included diabetes, lipid profiles, kidney function, environmental biomarkers, and select infectious diseases.

Results. Of the 3065 households approached, 2742 were eligible and 1827 were successfully screened (67%). A total of 1524 of eligible participants completed the survey (54%), for an overall response rate of 36%.

Conclusion. Completing a second NYC HANES a decade after the first study affords an opportunity to understand changes in prevalence, awareness and control of NCDs and evaluate municipal efforts to manage them.

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Introduction

In the United States, non-communicable diseases are the leading cause of poor health and health disparities, and they account for the vast majority of the nation's health care costs (Centers for Medicare and Medicaid Services, 2012; Bauer et al., 2014). Population health monitoring systems that provide accurate and reliable information about disease burden and trends are key resources to guide public health and clinical strategies (Institute of Medicine, 2011). With the

exception of a handful of national surveys, monitoring capacity at the state or local level for non-communicable diseases is largely limited to information obtained from self-reported surveys, hospitalization discharges, or mortality data.

Emerging approaches to more effectively track non-communicable diseases include expanding the use of biometrics in survey research, as well as extracting data from electronic health records and other health information technology. Over the past decade, initiatives in New York City (NYC) have incorporated both of these approaches to augment non-communicable disease surveillance. In 2004 the NYC Health Department was the first municipality to perform a population-based examination study on the health of adult residents using biometrics modeled after the National Health and Nutrition Examination Survey (NHANES) (Curtin et al., 2012). The intent of the New York City Health and Nutrition Examination Survey (NYC HANES), was to determine the population prevalence, awareness (proportion of disease diagnosed), treatment and control of a range of cardiovascular and other chronic disease-related health conditions using objective biometrics, as well as measure exposure to select environmental

Abbreviations: A1C (or HbA1c), hemoglobin A1c; ACASI, audio computer assisted self-interview; CARL, computer assisted recorded interview; CUNY SPH, City University of New York School of Public Health; DOHMH, Department of Health and Mental Hygiene; GIS, Geographic Information Systems; NHANES, National Health and Nutrition Examination Survey; NYC, New York City; NYC HANES, New York City Health and Nutrition Examination Survey; PHQ-9, Patient Health Questionnaire-9; PSU, Primary Sampling Unit; WHODAS, World Health Organization Disability Assessment Scale.

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toxins, screen for major mental health conditions, and develop a public health sera and urine bio-repository (Thorpe et al., 2006). Findings from NYC HANES 2004 guided citywide program and policy development for tobacco control, diabetes management, heavy metals exposure (Chamany et al., 2009; Ellis et al., 2009; McKelvey et al., 2011), and cardiovascular health (Angell et al., 2008; New York City Council, 2009, 2011; Thorpe et al., 2009; Upadhyay et al., 2010). More than 20 original scientific articles were published in peer-review journals, and both public-use and a query-able web-based datasets were made available (New York City Department of Health and Mental Hygiene).

In the decade after NYC HANES 2004 was conducted, NYC public health officials and other city leaders launched municipal health initiatives to improve built and food environments and the management of chronic diseases, such as expansion of the Smoke-Free Air Act (New York City Council, 2009, 2011), a ban on trans-fat use by restaurants (Board of Health, 2006), mandatory reporting of hemoglobin A1C laboratory results (Chamany et al., 2009), and a public-private partnership to achieve voluntary reductions in sodium levels in processed food (New York City Department of Health and Mental Hygiene). NYC also launched the Primary Care Information Project (PCIP), an initiative to subsidize and provide technical support to primary care practices for adopting electronic health record (EHR) systems, a network which now covers more than 2 million patients in NYC (New York City Department of Health and Mental Hygiene).

A second cross-sectional NYC HANES was launched in 2013 by the City University of New York School of Public Health (CUNY SPH) and the NYC Health Department with funding from a consortium of foundations. By maintaining consistency with NYC HANES 2004, the second survey collected citywide information on changes in chronic conditions and environmental exposures using physical exams and biomeasures. Given rising costs of maintaining periodic HANES-like objective surveys and the secular nationwide trend of declining survey response rates, the team also used this opportunity to validate new sources of data to obtain comparable information on chronic disease management. Building on NYC's large distributed EHR network, the team proposed EHR-based surveillance measures and modified NYC HANES to be able to validate key EHR-based measures using survey findings as a gold standard. This paper describes the rationale, design and methods used in NYC HANES 2013–2014. Response rates are also discussed. Specific aims of the study are summarized in Box 1.

Box 1

Primary aims of the New York City Health and Nutrition Examination Survey, 2013–2014.

To estimate the number and percentage of adults in NYC with selected diseases and risk factors, with an emphasis on cardiovascular risk factors, chronic health conditions, mental health conditions and environmental exposures.

To monitor trends in the health status of NYC adult residents across two time periods using biomeasures, physical examination and standardized survey findings.

To contribute to the evaluation of municipal policies and programmatic initiatives in NYC.

To evaluate the validity and reliability of using data from electronic health records for population health surveillance.

To expand the current citywide public health bio-repository, established in 2004 by NYC HANES, by adding serological and urine samples from a second time period (2013–2014).

To establish a citywide probability sample of metagenomic material from oral rinse samples for future microbiome research.

Methods

Sample design

As in 2004, NYC HANES was designed as a population-based, cross-sectional survey of adult residents of NYC, using a three-stage cluster sampling plan (Fig. 1). In the first stage, 144 segments were randomly selected with probability proportional to size from a sampling frame of 6236 segments across the city. Primary sampling unit (PSU) segments were based on counts of households from the 2010 U.S. Census and consisted of a block or proximal blocks within a given census tract with a required minimum total number of households.

A sampling frame of households within each selected PSU was obtained from a vendor, Marketing Service Group (MSG), derived from the U.S. Postal Service Delivery Sequence File. The address list accuracy was verified using geographic information system (GIS) software and NYC Department of City Planning geofiles to confirm that listed households were correctly located in the identified census tract/block group. Then, a systematic sample of housing units was selected within sampled PSUs to minimize impact of household-to-household “clustering”. Field staff visited all addresses identified in the Postal Delivery Sequence as ‘drop points’ (addresses with a single mail receptacle serving multiple units, resulting in no designation between units (Dekker et al., 2012)) and listed all units following standard listing procedures (Iannacchione et al., 2010). Household selection was performed with probabilities inversely proportional to selection probability for the PSU to produce an equal probability sample of housing units. Eligible adults aged 20 and older within selected households were randomly selected based on an a priori computer-generated sampling flag, designed to select zero (if no adult was eligible), one, or two adults from each household, depending on the total number of adult residents. At survey onset two adults were selected from any household with three or more adults; selection criteria were later modified to improve efficiency during data collection (October 26, 2013) to select two adults from households with two or more eligible adults.

The target sample size for NYC HANES 2013–2014 was 2000 adults, selected to ensure statistical power comparable with the annual NHANES surveys conducted since 1999 (Montaquilla et al., 2004). The study design team assumed that an initial eligibility screening questionnaire would be completed in 80% of households targeted and that 75% of eligible survey participants would complete the survey, yielding a final response rate of 60%.

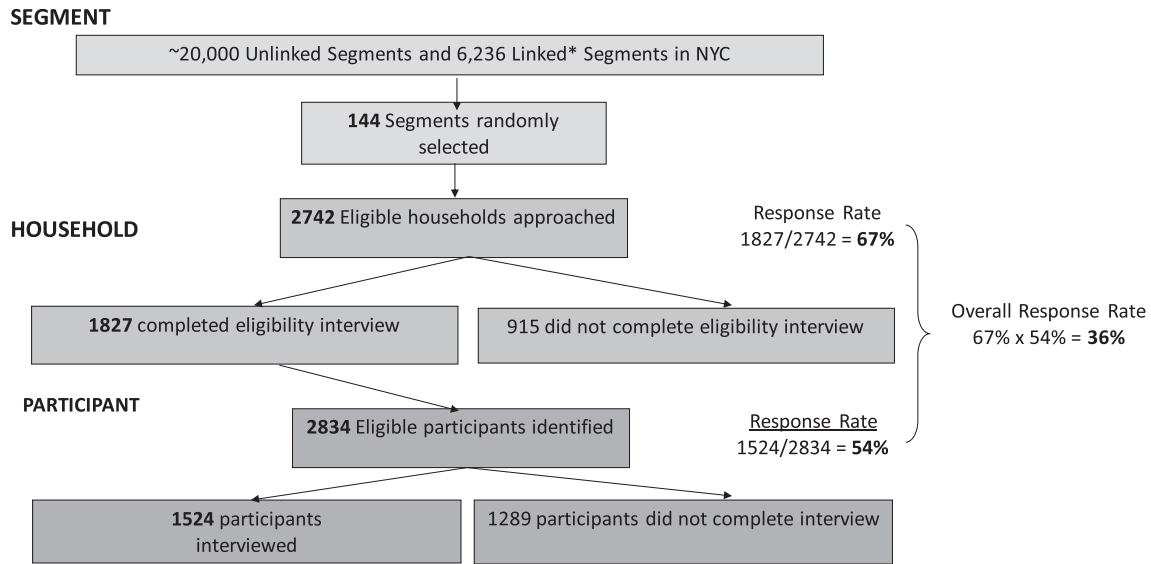
Survey data were weighted to adjust for complex sampling design, nonresponse, and post-stratification. A design weight equal to the inverse of the probability of household selection was applied to each household. A household-level non-response adjustment factor was then applied, and final weighting involved ‘raking’ sample weights so adjusted weights added to known marginal population totals for post-stratification categories of age, gender, race/ethnicity, borough, education and marital status, per the 2013 American Community Survey (United States Census Bureau, 2014).

Study population

Eligibility

To remain consistent with NHANES and NYC HANES 2004, the target population consisted of non-institutionalized adults aged 20 years or older residing in the five boroughs of NYC, including non-English speakers, illiterate individuals, pregnant women, and mentally or developmentally disabled individuals. Adults living in group quarters, such as adults living in college dormitories and military or other non-institutional group quarters, a population that has been estimated to comprise 3.1% of the total population of NYC, were excluded (United States Census Bureau, 2001).

a) Sampling Design



(*) Small segments were grouped to achieve a minimal population size

b) Response rate breakdown

Segment	Un-linked Segments in NYC Linked Segments in NYC Segments Randomly Selected	~20,000 6236 144		
Households	Household Approached	3087	Household Response Rate: 1827/2742 = 67%	Study Response Rate: 67% * 54% = 36%
	- Ineligible Households (Vacant, Group Quarters, Businesses)	345		
	- Eligible Households Approached	2742		
	- Completed eligibility interview	1827		
	- Refused screening	543		
- Unable to contact	359			
- Persistent language barriers	13			
Participants	Participants Identify	2848	Participant Response Rate: 1524/2834 = 54%	
	- Ineligible Participants	35		
	- Eligible Participants	2834		
	- Completed interview	1524		
	- Refused to participate	883		
	- Unable to contact	283		
	- Unable to participate (travel, change of residence)	72		
	- Physically or mentally unable to participate	44		
	- Language barriers	6		

Fig. 1. Sampling design and response rate for NYC HANES 2013–2014. a. Sampling Design. b. Response rate breakdown.

Outreach and recruitment

As part of the study's outreach and recruitment strategy, a website was created (www.nychanes.org), with four key messages appealing to personal and civic motivations to complete the study: *get a free check up, receive \$100, improve city life and be counted*. Messages were also incorporated into a flier and detailed brochure prepared at a sixth grade reading level and translated into Spanish, Russian and Chinese. Study staff also created a professional video for the website to visually demonstrate and explain the study to potential participants, routinely updated a dedicated Facebook page, and placed recruitment postings on 26 neighborhood blogs. Elected officials, such as the Mayor and legislative representatives at the city, state and national levels, as well as numerous health, community and religious organizations were asked to support the survey by signing a letter of endorsement; signed letters were posted on the website. A targeted media campaign was launched 6 weeks into the survey.

Selected households were mailed an introductory letter describing the study during the first 1–3 weeks of field data collection. Letters were addressed to "Resident" unless a name was obtained from MSG. Field interviewers then visited households 7 days per week and at varying times, attempting to speak with an adult resident. They carried copies of the introductory letter in English and the ten most frequently

spoken other languages in NYC (Spanish, Russian, Chinese, Korean, Haitian Creole, Bengali, Italian, Polish, Arabic, and Yiddish). If an adult was present, the field staff member explained the survey and completed a screening questionnaire, including the name (or initials), age, and sex of each household member. Field interviewers explained to selected survey participants they could receive up to \$200 cash upon completion of all 3 survey components, and that they would receive laboratory test results valued at more than \$500.

Survey participants could complete the interview, exam and specimen collection at home or at a designated survey clinic site located in Manhattan. Participants could opt to do the survey, physical exam and most specimen collection at the time of household screening and then schedule the phlebotomy at a later time. Otherwise, participants selected a date and time for the full study and received a reminder call 48 h before the scheduled appointment. Bilingual field staff conducted interviews in Spanish, Russian and Chinese, and a telephone-based language translation service was used for participants speaking other languages.

In households in buildings with doormen who were reluctant to provide field staff with direct access to tenants, the study team attempted to contact building management companies through phone calls, FedEx letters and in-person visits to describe the survey and to seek permission to speak with tenants.

Data collection

A summary of the components of the NYC Health and Nutrition Examination Survey 2013–2014 is provided in Table 1. CUNY SPH and the NYC Health Department contracted with a vendor, RTI International, to develop the data collection applications and perform field data collection. The study protocol was reviewed and approved by the institutional review boards at CUNY SPH, NYC Health Department and RTI international. Field interviewers obtained written informed consent from participants after reviewing a detailed study brochure. Participants consented separately for each portion of the study.

The interview consisted of a face-to-face interview and an audio computer-assisted self-interview (ACASI) (Metzger et al., 2000). In the face-to-face interview, trained interviewers asked participants questions about their health behaviors, medical history, health care access and use, nutrition, and demographic information. This section also assessed mental health status using the Patient Health Questionnaire-9 (PHQ-9) (Kroenke et al., 2001), Kessler-6 (Kessler et al., 2003) and World Health Organization Disability Assessment Scale (WHODAS) (WHO, 2010) instruments. The ACASI used a fully automated computer interface to prompt questions and to record responses in either English or Spanish regarding sensitive topics, including drug use, sexual behavior, and incarceration. Speakers of other languages were not eligible to complete the ACASI. Randomized controlled trials comparing data from ACASI with data from face-to-face interviews have shown that sensitive behaviors are more frequently reported in settings using ACASI technologies (Metzger et al., 2000). At the end of the interview,

all participants were provided with a resource sheet with health hotlines and resources.

Physical examination

The physical exam included height, weight, waist circumference, blood pressure and pulse measurements. Field interviewers were trained and certified in standardized protocols. Because the majority of interviews were expected to take place in participants' homes, protocols were developed to accommodate the use of portable equipment. For the physical exam, equipment included a portable digital scale (Taylor 7081), steel tape measure and carpenter's square (height measurement), stadiometer for use in the clinic only (Seca 213), measuring tape for waist circumference (Seca 201), and an automatic inflatable digital blood pressure monitor and four cuff sizes (Life Source UA-789 AC). The base unit for the selected digital monitor had previously been evaluated for validity and reliability and was found to perform well (Longo et al., 2003). Blood pressure measurements were taken three times for each participant. The mean value of the last two of the three values was recorded as the final blood pressure measurement. Weight was collected to the nearest 0.1 kg and height and waist circumference to the nearest 0.5 cm. Protocols for physical examination procedures were adapted from the NHANES Medical Examination Component (MEC) manuals (Centers for Disease Control and Prevention, 2013).

Biospecimen collection

Field interviewers were trained to collect urine and oral rinse specimens, and phlebotomists collected blood specimens. Approximately 38 ml of blood and a target of 25 ml of urine were collected from consenting participants. All specimens were transported per protocol, and aliquots were shipped to laboratories to be analyzed or stored (see Appendix). Specimens were refrigerated during transport to the NYC Health Department's Public Health Laboratory, centrifuging some blood tubes within 2 h (often in the field), and aliquoting blood within 24 h and urine within 72 h. Phlebotomists used portable centrifuges, and field interviewers and phlebotomists shipped specimens using overnight shipping services and ice packs when necessary to meet processing specifications. The Public Health Laboratory received and processed specimens 7 days a week and shipped in batches to external testing laboratories, selected to be consistent with NHANES and NYC HANES 2004 testing methods.

Quality assurance and data management

All field interviewers and phlebotomists were trained on measurement techniques according to a standardized protocol (Ostchega et al., 2003). Computer-assisted recorded interviewing (CARI) was used to review each interviewer's first two completed interviews plus a random 10% of all completed interviews. Quality assurance reports were reviewed on a regular basis to evaluate key measures, including means and distributions for height, weight, and blood pressure. Each testing laboratory implemented quality-control procedures to ensure that laboratory-reported values were accurate and reliable, including comparisons with control specimens in each analytical run.

Notification of laboratory findings and referrals

Study investigators reported indicators of serious health problems to participants as soon possible after detection. For critical conditions, NYC Health Department physicians discussed findings by phone with participants and urged them to see a medical provider for an evaluation or go to a hospital emergency department. Serious health problems included participants expressing active suicidal ideation, extreme hypertension, fasting plasma glucose greater than 350 mg/dL, blood creatinine greater than 2 mg/dL, an albumin-to-creatinine ratio of greater than 300, or extremely elevated levels of mercury, lead or cadmium. Positive test results for hepatitis B and C were provided by letter and phone call. A final

Table 1
Components of the New York City Health and Nutrition Examination Survey, 2013–2014.

Two-part interview		
Face to face		
Computer-assisted self-interview		
Physical examination		
Systolic blood pressure		
Diastolic blood pressure		
Pulse		
Height		
Weight		
Standing waist girth		
Biologic specimen collection		
Blood	Urine	Oral rinse
Lipid profile	Trace metals	Human papilloma virus
Total cholesterol	Mercury	Oral rinse repository
High-density lipoprotein	Albumin	
Low-density lipoprotein ^a	Urine creatinine	
Triglycerides ^a	Urine repository	
Diabetes profile		
Fasting plasma glucose ^a		
Hemoglobin A1c		
Creatinine		
Hepatitis B virus		
Core antibody		
Surface antigen		
Surface antibody		
DNA		
Hepatitis C virus		
Antibody		
RNA		
Hepatitis E virus		
Antibody		
RNA		
Cotinine		
Heavy metals		
Cadmium		
Lead		
Mercury		
Serum repository		

^a Test was administered only to participants who had fasted for 9 or more hours.

report of all examination findings, including laboratory tests, was sent within 14 to 18 weeks of the examination.

Results

NYC HANES began screening activities in August 2013. Of the 3065 originally selected households, 345 were deemed not to be households or were group quarters and thus ineligible; an additional 22 housing units were selected following protocols for identifying units missed on the sampling frame, for a final sample of 2742 eligible households. A total of 1827 of these households were successfully screened (67%). Of the 915 households not screened, refusals to screen accounted for 60%, inability to enter the home or contact the resident accounted for 39%, and persistent language barriers accounted for 1%.

Of the 1827 households with completed screening questionnaires, 2834 eligible adults were selected for participation in the survey. By the end of data collection in June 2014, 1524 selected participants completed the survey and were deemed eligible, for an overall response rate of 36% (Fig. 1). A comparison between the unweighted demographic characteristics of survey participants and characteristics after weighting for age, sex, race/ethnicity, marital status and education showed only modest changes (Table 2). In terms of other components of the study, nearly all participants completed the physical exam (n = 1497, or 98%), provided urine (n = 1446, or 95%) and oral rinse (n = 1455, or 95%) biospecimens. A total of 1207 participants provided viable blood samples (79%).

Table 2

Relative unweighted and weighted distribution of demographic characteristics used in non-response weighting: age, sex, marital status, racial/ethnic background, and education, NYC HANES 2013–2014.

Characteristic	Unweighted Distribution		Weighted Distribution	
	N	%	Wt. N	Wt. %
Total	1524	100	6285749	100
Borough				
Manhattan	315	20.7	1324631	21.1
Bronx	220	14.4	982333	15.6
Brooklyn	491	32.2	1872927	29.8
Queens	394	25.8	1748731	27.8
Staten Island	104	6.8	357128	5.7
Age group				
20–34	552	36.2	2064647	32.8
35–49	396	26.0	1702255	27.1
50–64	364	23.9	1487768	23.7
> = 65	212	13.9	1031079	16.4
Gender				
Men	643	42.2	2945581	46.9
Women	881	57.8	3340169	53.1
Marriage Status				
Never married ^a	653	42.6	2487720	39.6
Married	589	38.7	2677674	42.6
Widowed, divorced, separated	282	18.5	1120356	17.8
Race/ethnicity ^b				
Non-Hispanic white	512	33.6	2201256	35.1
Non-Hispanic black	340	22.3	1338503	21.3
Hispanic	389	25.6	1700840	27.1
Asian	203	13.3	877212	14
Other ^c	78	5.1	159329	2.5
Education ^b				
Less than high school graduate	316	20.8	1174034	18.7
High school graduate, GED, or alternative	244	16.0	1494853	23.8
Some college or associate's degree	336	22.1	1423008	22.7
College graduate or higher	626	41.1	2187158	34.8

^a Includes single and living with a partner.

^b Does not include information from 3 participants refused to answer race/ethnicity or education questions.

^c Includes multiracial (more than one race).

Conclusion

As a periodic, intensive examination study, NYC HANES aims to augment ongoing local population health monitoring efforts in NYC for prevalence, awareness, treatment and control of chronic conditions, as well track other conditions benefitting from objective biomeasure assessment. Through its public use products and biorepository, the study also aims to stimulate research informing public health practice and policymaking, particularly pertaining to urban settings. In 2004, NYC HANES was the first community-level attempt to replicate core aspects of NHANES, and to our knowledge, only two other jurisdictions, the states of Wisconsin and Arkansas, have since implemented a comparable population-based health examination survey (Nieto et al., 2010; Arkansas Department of Health, 2014). Completion of a second NYC HANES, one decade after the first survey, provides an opportunity to evaluate municipal efforts to improve the city's capacity to diagnose and manage leading causes of morbidity and mortality in the context of local public health initiatives. Benchmarking of data collection methods and laboratory testing facilities against NHANES allows us to contrast findings in New York City with national secular patterns.

Notwithstanding the broad utility of findings generated from NYC HANES, a number of factors influence the feasibility of repeating NYC HANES on a periodic basis in the future. First, we observed a 34% decline in response rate across the two studies. Minor changes in recruitment approach in 2013–2014 may have contributed to this reduction, such as more stringent eligibility requirements for who could respond to screening questions and a more extensive and item-by-item informed consent process. However, the large number of households opting to not speak with us and the high proportion of households that we had no contact with despite many attempts, suggest that such studies are decreasingly acceptable or convenient for NYC residents. The declining response rate we experienced mirrors similar trends nationwide towards poorer survey response rates (National Research Council, 2013). While few studies have systematically documented reasons for non-response trends, expert consensus suggests that the public feels over-solicited, concerned about confidentiality and data security, more wary of government intrusion, and generally too busy compared with 10 years ago (Curtain et al., 2005). Declining response rates and high cost (nearly \$3000 per completed interview) make large-scale community-based population-based examination surveys such as NYC HANES an unlikely model for enhanced chronic disease surveillance within local jurisdictions in the future.

For that reason, NYC HANES 2013–2014 was also designed to evaluate the validity and reliability of using clinical data from a large electronic health records network for population health surveillance. Prior to data collection for NYC HANES, the study investigators published a planning document entitled *Developing an Electronic Health Record-Based Population Health Surveillance System* (McVeigh et al., 2013), describing how the research team designed and operationalized a new surveillance system known as the NYC MacroScope, with input from an expert Advisory Board from around the country. Briefly, NYC MacroScope uses EHRs from a large network of primary care practices across NYC to track conditions important to public health, with a focus on chronic conditions. Findings from this evaluation are forthcoming. As primary care practices increasingly adopt electronic health records, the potential to monitor chronic disease management at the population level grows. Emerging innovations in survey research methods and health-related technologies will help inform the most effective approaches to study population health going forward.

Conflict of interest and financial disclosure statement

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Department of Health and Mental Hygiene, Hunter College Office of the Provost, the CUNY Vice Chancellors Office of Research, and CUNY School of Public Health Dean's Office. The authors (LT, CG, AF, ES, JR-L, MF, AP, CC, EL, MF, RK, and SP) declare that there are no conflicts of interest.

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