Can Electronic Health Records be Used for Population Health Surveillance? Findings from the NYC Macroscope

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“If we have data, let’s look at data. If all we have are opinions, let’s go with mine.”

- Jim Barksdale, former Netscape CEO

Good data allow for:

- Better policy and programmatic decisions
- Advocacy
- Evaluation/accountability
- Use resources more efficiently
Traditional surveillance methods include:

- Birth and death certificates
- Notifiable disease reporting
- Hospitalization records
- Surveys
Electronic Health Record Use Has Increased in the Past Decade

Potential to Use EHRs for Population Health Surveillance

Traditional surveys are very valuable, but becoming more difficult to conduct.

- Telephone survey response rates decreasing
- Examination surveys are extremely expensive, labor intensive, often have lengthy lag times between data collection and dissemination.

EHR-based surveillance can complement existing surveillance systems.

May be only source of information in jurisdictions with limited local data.
Possible Limitations to EHR-Based Surveillance

- Only those in care
- Patients and providers in an EHR network may not be representative
- If data are aggregated, there may be duplicate records
- Data may not be collected and recorded in uniform way
- Data may be in free text or other field that is difficult to access
The **NYC Macrooscope** uses primary care practice data from an EHR network to track conditions important to public health, focusing on chronic conditions.

Led by NYC Health Department, in partnership with NYUMC (formerly at CUNY)
NYC’s EHR Network: Primary Care Information Project (PCIP)

Bridges public health and healthcare

“The Hub” allows secure exchange of aggregate data with PCIP practices through a distributed model

The Hub currently covers:

- Nearly 700 practices
- 1.9 M patients in 2013
Key Features of NYC Macroscope

- Hub Population Health System
  - eClinicalWorks EHR platform

Inclusion/exclusion criteria
- Practice – Documentation quality thresholds guided by Meaningful Use standards
- Provider – Primary care only
- Patient – Visit in 2013, ages 20-100, sex recorded as male or female, NYC Zip Code
All Adult NYC Patients: 1,317,438 (n=660 practices, 2229 providers)

Seen by primary care, not specialist: 766,655

Retained after quality inclusion criteria: 716,076
(n=393 practices, 953 providers)

2013 Macrooscope primary care coverage: ~17%*

*Denominator is CHS 2013 estimates of 4,137,212 NYC adults (20+) that saw provider in 2013
Weighted to the distribution of the NYC adult population that had seen a health provider in the past year.

Validated against 2 population-based reference surveys:

- 2013-14 NYC Health and Nutrition Examination Survey (NYC HANES)
  - N = 1,527; 1,135 in care
- 2013 NYC Community Health Survey (CHS)
  - N = 8,356; 6,166 in care
<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Population Subgroups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevalence, Treatment and Control</td>
<td>Sex</td>
</tr>
<tr>
<td>• Diabetes</td>
<td>• Male</td>
</tr>
<tr>
<td>• Hypertension</td>
<td>• Female</td>
</tr>
<tr>
<td>• Cholesterol</td>
<td></td>
</tr>
<tr>
<td>Prevalence</td>
<td>Age</td>
</tr>
<tr>
<td>• Obesity</td>
<td>• 20-39</td>
</tr>
<tr>
<td>• Smoking</td>
<td>• 40-59</td>
</tr>
<tr>
<td>• Depression</td>
<td>• 60-100</td>
</tr>
<tr>
<td>Use of Preventive Services</td>
<td></td>
</tr>
<tr>
<td>• Vaccination against influenza</td>
<td></td>
</tr>
<tr>
<td>Indicator</td>
<td>Macroscopic 2013 (n=716,076)</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>Obesity (BMI)</td>
<td>Measured height, weight</td>
</tr>
<tr>
<td>Smoking (current smoker)</td>
<td>Structured smoking section**</td>
</tr>
<tr>
<td>Hypertension, diabetes and cholesterol diagnosis</td>
<td>Ever diagnosed</td>
</tr>
<tr>
<td>Diabetes Augmented</td>
<td>Ever diagnosed** or A1c≥6.5** or Medication prescribed</td>
</tr>
<tr>
<td>Hypertension Augmented</td>
<td>Ever diagnosed* or Systolic≥140, diastolic≥90* or Prescribed meds*</td>
</tr>
<tr>
<td>Cholesterol Augmented</td>
<td>Ever diagnosed or Total cholesterol≥ 240** or Medication prescribed</td>
</tr>
<tr>
<td>Depression</td>
<td>PHQ-9≥10 or ever dx</td>
</tr>
<tr>
<td>Influenza Vaccination</td>
<td>CVX, CPT or ICD-9 code*</td>
</tr>
</tbody>
</table>

* In the past calendar year.
** In the past 2 calendar years.
Validation Study Results

POPULATION-BASED PREVALENCE ESTIMATE COMPARISONS
Validating NYC Macroscope by Comparison with Existing Surveys

Used a priori criteria to determine if estimates were comparable enough to well-established surveys to consider using for population health surveillance.

<table>
<thead>
<tr>
<th>Test for Comparison</th>
<th>Metric</th>
<th>Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistical Equivalence</td>
<td>Two One-Sided Test (TOST)</td>
<td>P &lt;0.05</td>
</tr>
<tr>
<td>Statistical Difference</td>
<td>Student’s T-Test</td>
<td>P &lt;0.05</td>
</tr>
<tr>
<td>Relative Difference</td>
<td>Prevalence Ratio</td>
<td>0.85-1.15</td>
</tr>
<tr>
<td>Prevalence Difference</td>
<td>Prevalence 1 – Prevalence 2</td>
<td>+- 5 points</td>
</tr>
<tr>
<td>Consistency across 6 strata (age x sex)</td>
<td>Spearman Correlation</td>
<td>&gt;= 0.80</td>
</tr>
</tbody>
</table>
Prevalence of Selected Indicators

- Hypertension Diagnosis
- Obesity Diagnosis
- Diabetes Diagnosis
- Smoking
- Depression
- Influenza Vaccination

NYC Macroscope
NYC HANES
Community Health Survey

**Performing well**

**Performing poorly**
NYC Macrooscope 2013, NYC HANES 2013-14 and the 2013 Community Health Survey, New York City Adults in Care in the Past Year

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Hypertension</th>
<th>Smoking</th>
<th>Diabetes</th>
<th>Obesity</th>
<th>Hypercholesterolemia</th>
<th>Depression</th>
<th>Influenza Vaccination</th>
</tr>
</thead>
<tbody>
<tr>
<td>NYC Macrooscope % (95% CI)</td>
<td>32.3 (32.2, 32.4)</td>
<td>15.2 (15.1, 15.3)</td>
<td>13.9 (13.8, 14.0)</td>
<td>27.8 (27.7, 27.9)</td>
<td>49.3 (49.1, 49.5)</td>
<td>8.2 (8.1, 8.2)</td>
<td>20.9 (20.8, 21.0)</td>
</tr>
<tr>
<td>NYC HANES % (95% CI)</td>
<td>32.5 (29.4, 35.7)</td>
<td>17.7 (15.1-20.8)</td>
<td>12.6 (10.6, 14.8)</td>
<td>31.3 (28.5-34.2)</td>
<td>46.9 (42.6, 51.3)</td>
<td>15.2 (13.0 – 17.7)</td>
<td>47.6 (44.0-51.3)</td>
</tr>
<tr>
<td>Community Health Survey % (95% CI)</td>
<td>31.6 (30.18, 33.0)</td>
<td>14.9 (13.6-16.3)</td>
<td>12.5 (11.5, 13.6)</td>
<td>24.7 (23.2-26.3)</td>
<td>47.9 (45.7, 50.1)</td>
<td>n/a</td>
<td>47.3 (45.5-49.0)</td>
</tr>
</tbody>
</table>

NYC Macrooscope vs. NYC HANES

<table>
<thead>
<tr>
<th>Test</th>
<th>Absolute Difference &lt; 5</th>
<th>Prevalence Ratio of 0.85 - 1.15</th>
<th>Test of Difference (t-test) p&gt;0.05</th>
<th>Test of Equivalence (TOST) p&lt;0.05</th>
<th>Spearman Correlation r≥0.80</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Ready for Use</td>
</tr>
<tr>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Ready for Use</td>
</tr>
<tr>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Ready for Use</td>
</tr>
<tr>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Ready for Use</td>
</tr>
<tr>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Use with caution</td>
</tr>
<tr>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Not ready for use</td>
</tr>
<tr>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Not ready for use</td>
</tr>
</tbody>
</table>

✓=Criterion met  x=Criterion not met
SENSITIVITY AND SPECIFICITY OF NYC MACROSCOPE INDICATORS
NYC Macroscope prevalence estimates are similar to estimates from our gold standard surveys for measures of obesity, smoking, diabetes, hypertension, and hypercholesterolemia.

But,

- Was the similarity a reflection of good measurement properties or cross-canceling errors?

- Were these results generalizable to other EHR systems?
To answer these questions, we

- Recruited NYC HANES participants who had visited a doctor in the past year (consent/HIPAA)
- Obtained printed copies of EHR records by secure FAX
- Abstracted data from medical records of NYC HANES participants
- Used NYC Macroscope indicator algorithms to classify patient outcomes
- **For each individual**, linked NYC Macroscope and NYC HANES outcome classifications and assessed whether those classifications were similar or different
- **Across individuals**, computed sensitivity and specificity to summarize the agreement between NYC Macroscope and NYC HANES classifications
Sensitivity and Specificity

**Sensitivity**

100% Sensitivity

- Positive test: Blue = has the condition
- Negative test: Green = does not have the condition

**Specificity**

100% Specificity

- Positive test: Blue = has the condition
- Negative test: Green = does not have the condition
Measures

Outcomes limited to those that had performed well in population level analysis

- Smoking,
- Obesity,
- Hypertension (2),
- Diabetes (2)
- Hypercholesterolemia (2)
Statistical Analysis

Sensitivity and specificity of NYC Macroscope indicator definitions

- In data from providers who contribute to the NYC Macroscope
- In data from practices that do not contribute to the NYC Macroscope

Validity threshold: Sensitivity $\geq 0.70$ AND Specificity $\geq 0.80$
Sensitivity Analyses

Meaningful Use

Unstructured Data
Participant Inclusion/Exclusion Flow Chart

Enrolled in NYC HANES 2013-14  
N=1,524

Had a doctor visit in past year  
n=1,135

Signed consent  
n=692

Signed HIPAA waiver  
n=491

One or more EHRs obtained  
n=277

EHR contained valid data  
n=190

Not in care  
n=389

No consent  
n=443

No HIPAA waiver  
n=201

No EHR, no visits, specialist, unable to locate, not released  
n=214

Excluded provider type  
n=87

NYC Macroscope records  
n=48

Non-Macroscope records  
n=142
Samples

<table>
<thead>
<tr>
<th>Number</th>
<th>NYC Macroscope</th>
<th>All Records</th>
<th>MU1 Subsample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Records/Patients</td>
<td>48</td>
<td>142</td>
<td>86</td>
</tr>
<tr>
<td>Providers</td>
<td>39</td>
<td>133</td>
<td>79</td>
</tr>
<tr>
<td>Practices</td>
<td>34</td>
<td>89</td>
<td>49</td>
</tr>
<tr>
<td>EHR Vendor Platforms</td>
<td>1</td>
<td>&gt;20</td>
<td>&gt; 15</td>
</tr>
</tbody>
</table>

No significant differences in patient characteristics across samples
48 NYC Macroscope Records

**Sensitivity**

- Obesity
- Smoking
- Diabetes Diagnosis
- Augmented Diabetes
- Hypertension Diagnosis
- Augmented Hypertension
- Hypercholesterolemia Diagnosis
- Augmented Hypercholesterolemia

**Specificity**

- Obesity
- Smoking
- Diabetes Diagnosis
- Augmented Diabetes
- Hypertension Diagnosis
- Augmented Hypertension
- Hypercholesterolemia Diagnosis
- Augmented Hypercholesterolemia

**Validity threshold ≥ 0.70**

**Validity threshold ≥ 0.80**
Sensitivity

Validity threshold ≥ 0.70
Sensitivity

Validity threshold ≥ 0.70
Specificity

- Augmented Hypercholesterolemia
- Hypercholesterolemia Diagnosis
- Augmented Hypertension
- Hypertension Diagnosis
- Augmented Diabetes
- Diabetes Diagnosis
- Smoking
- Obesity

Validation threshold ≥ 0.80

- All Non-Macroscope Records (n=142)
- Non-Macroscope with MU1 Restriction (n=86)
- NYC Macroscope (n=48)
Summary

Both indicators of hypercholesterolemia performed poorly

All other measures performed well

The above conclusions are consistent across NYC Macroscope and Non-Macroscope records

Restricting records to those from providers who have attested to stage 1 Meaningful Use improved the sensitivity of the obesity, smoking and hypertension diagnosis indicators
Strengths

- Heterogeneity of providers (N = 172) and EHR vendor platforms (N > 20)
- Innovative sample and gold standard criterion

Limitations

- Small sample size/large confidence intervals
Conclusions

NYC Macroscope indicators of obesity, smoking, diabetes and hypertension prevalence are ready for use by NYC Macroscope.

NYC Macroscope indicator definitions of obesity, smoking, diabetes and hypertension are generalizable to EHR data from other sources.

Further work is required to develop valid indicators of hypercholesterolemia.

Incorporating meaningful use criteria into EHR surveillance system design may improve validity, especially for obesity, smoking and hypertension diagnosis indicators.
The New York City Macroscope
Using Data from Electronic Health Records for Population Health Surveillance

WHAT HAVE WE LEARNED?
What are our aspirations for population health surveillance using EHRs?

- Improved ability to monitor burden of key health conditions (*timeliness, completeness, smaller areas, smaller populations*)
What are our **aspirations** for population health surveillance using EHRs?

- **Improved ability to monitor burden** of key health conditions *(timeliness, completeness, smaller areas, smaller populations)*
  - **IMPORTANT CONTEXT:** Meaningful Use (MU) criteria have incentivized hospitals and practices to **record** and **exchange** structured data on patients
    - Focus has been on improving syndromic surveillance, immunization, and electronic laboratory reporting
    - Hospital MU reporting is rapidly improving. Primary care practices (PCP) are adopting EHRs, but face larger challenges achieving MU or other incentivized criteria
    - **Still…** EHR expansion among PCPs extends surveillance opportunities to chronic disease prevalence, behavioral risk factors and clinical preventive services
What are our aspirations for population health surveillance using EHRs?

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    - *Still...*EHR expansion among PCPs extends surveillance opportunities to chronic disease prevalence, behavioral risk factors and clinical preventive services

- Improved ability to monitor quality of clinical care (disease management)
  - Unique aspiration of EHR-based surveillance, beyond what telephone surveys or claims data can provide
What Impact Does Coverage and Representativeness of NYC Macroscope Sample Have?

- NYC Macroscope sample represented 17% of the 4.1 million adult New Yorkers in care in 2013.
- Approximately 10% of all primary care providers in NYC.
- Population coverage ranged from 8%-47% across neighborhoods.
- Lower penetrance in more affluent areas of the city.

Newton-Dame et al, eGEMS 2016
Before weighting, patients in NYC Macroscope were younger and more likely to be living in high poverty neighborhoods than NYC adults in care overall.

By statistically weighting to as many factors as available in both EHR and ‘gold standard’ data sources, we sought to reduce selection bias.

For most indicators with low measurement error, prevalence estimates were comparable to ‘gold standard’ survey, suggesting minimal selection bias.

Newton-Dame et al, eGEMS 2016
• Approximately 75% of the NYC adult population is “in care” (seen provider in past year)
  In-care population more likely to be: Older, female, non-Hispanic and insured
  …more likely to have: Diabetes, hyperlipidemia, and hypertension

• Changing proportions of the population that is uninsured/underinsured over time can influence surveillance validity (uncertain future of ACA)

  Currently may be inappropriate to generalize findings from primary care EHR systems in the United States to the total population (including persons not in care)

Romo et al, Preventing Chronic Disease 2016
How does Missing Data Influence Prevalence and Control Estimates?

- **NYC Macroscope missing data at the patient level varied by indicator**
  - Very low for BMI and blood pressure
    - <2% missing for BP among patients with hypertension
    - <8% missing for BMI
  - High for smoking and labs for diabetes and cholesterol
    - 23% of patients with hyperlipidemia missing cholesterol lab results
    - 27% of patients with diabetes missing A1C lab results
    - 32% missing smoking status
    - 66% missing depression screening

- **Patient-level missingness was clustered within clinical practices**
  - ~15% of practices were missing labs on >50% of their patients

Reflects that some practices still lack lab interfaces, and some providers are not ordering labs or screening as recommended, some information stored in wrong fields. **MU attainment improves these statistics.**
NYC Macroscope Findings -- Consistency with Other Studies

- Findings on hypertension, diabetes, obesity, and smoking highly robust and consistent with other studies

### Hypertension and Diabetes Prevalence

<table>
<thead>
<tr>
<th>Prevalence Estimate</th>
<th>Hypertension</th>
<th>Diabetes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic</td>
<td>Augmented</td>
</tr>
<tr>
<td>NYC Macroscope</td>
<td>32.3%</td>
<td>39.2%</td>
</tr>
<tr>
<td>NYC HANES</td>
<td>32.5%</td>
<td>40.3%</td>
</tr>
</tbody>
</table>

**Hypertension and Diabetes Prevalence**

- Consistent with findings from 4 other countries using primary care EHR data
- Sensitivity same or slightly higher than other individual-level validation studies in Canada and Sweden
- Augmented definition – using meds & lab information in EHRs
  - Performs well at identifying ‘undiagnosed’ hypertension
  - Diabetes prevalence is higher in NYC HANES than Macroscope (reflecting risk-based A1c screening in clinical practices vs universal screening in survey)
NYC Macroscope Findings -- Consistency with Other Studies

- Findings on **hypertension, diabetes, obesity, and smoking** highly robust and consistent with other studies

<table>
<thead>
<tr>
<th>Prevalence Estimate</th>
<th>Obesity</th>
</tr>
</thead>
<tbody>
<tr>
<td>NYC Macroscope</td>
<td>27.9%</td>
</tr>
<tr>
<td>NYC HANES</td>
<td>31.3%</td>
</tr>
<tr>
<td>NYC CHS</td>
<td>24.7%</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>0.92</td>
</tr>
<tr>
<td>Specificity</td>
<td>0.97</td>
</tr>
</tbody>
</table>

**OBESITY AND SMOKING PREVALENCE**

- NYC Macroscope estimates are lower than NYC HANES, yet estimates are closer to directly-measured NYC HANES than widely used telephone survey estimate
- Sensitivity and specificity indicate little measurement error, consistent with other published chart reviews
- Obesity has minimal missing data, smoking has substantial missing data, but appears to be non-differential (by age group, sex and neighborhood poverty)
Areas still in need of improvement: Hyperlipidemia Prevalence

- Validation of hyperlipidemia estimates less successful – similar to experiences elsewhere

<table>
<thead>
<tr>
<th>Prevalence Estimate</th>
<th>High Cholesterol</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic</td>
<td>Augmented</td>
</tr>
<tr>
<td>NYC Macroscope</td>
<td>49.3%</td>
<td>54.5%</td>
</tr>
<tr>
<td>NYC HANES</td>
<td>46.9%</td>
<td>56.8%</td>
</tr>
</tbody>
</table>

**HYPERLIPIDEMIA PREVALENCE**

- Consistent with 3 other countries, our validation did not identify that EHR estimates were statistically equivalent to survey measures
- Sensitivity and specificity were below thresholds in all samples
- Longer screening interval, shifting definitions, and diagnosis/treatment dependence on other factors may contribute to poor estimation
Areas still in need of improvement: Treatment and Control Measures

- Few studies have examined the ability of EHR records to estimate treatment and control of chronic diseases
- Our study found treatment and control of hypertension, diabetes, and hyperlipidemia performed poorly
  - Definitions more complex than prevalence (requiring long medication lists, lab results, and nested queries)
  - Statistical power for comparisons limited by small sample sizes of diagnosed adults in NYC HANES

Table 3b. Control of Diagnosed Cardiovascular/Metabolic Conditions among New York City Adults in Care, Past Year (2013)

<table>
<thead>
<tr>
<th>OUTCOME</th>
<th>2013 NYC MACROSCOPE&lt;sup&gt;a&lt;/sup&gt;</th>
<th>2013 NYC HANES</th>
<th>STATISTICALLY</th>
<th>EQUIVALENT</th>
<th>DIFFERENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% (95% CI)</td>
<td>% (95% CI)</td>
<td>(TOST&lt;sup&gt;c&lt;/sup&gt;)</td>
<td>(T TEST)</td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>65.7 (65.3-66.0)</td>
<td>58.5 (51.1-65.6)</td>
<td>0.72</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>87.1 (86.9-87.3)</td>
<td>79.3 (73.2-84.3)</td>
<td>0.84</td>
<td>0.006</td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>80.4 (79.9-80.9)</td>
<td>82.6&lt;sup&gt;a&lt;/sup&gt; (68.2-91.3)</td>
<td>0.31</td>
<td>0.71</td>
<td></td>
</tr>
</tbody>
</table>

Needs Improving:
- EHR coverage
- Provider representation
- Patient-level documentation
- Proper disease management
Next Steps

• Analyzing trend data (2012-2015)
  o Validate trends against the NYC Community Health Survey
  o Examine data by race and health disparities

  ▪ Constructing and validating small geographic area estimates
  ▪ Developing and testing additional indicators (e.g. childhood obesity)
Thank you!

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Lorna Thorpe: lorna.thorpe@nyumc.org

We can also be reached at nycmacroscope@health.nyc.gov, or search for “NYC Macroscope”.
## Indicator Definitions

### Table 1: Indicator Definitions in NYC Macroscope 2013, NYC HANES 2013-14 and CHS 2013

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Type</th>
<th>NYC HANES</th>
<th>CHS</th>
<th>NYC Macroscope</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(n=1,115)</td>
<td>(n=6,166)</td>
<td>(n=716,076)</td>
</tr>
<tr>
<td>Smoking</td>
<td>Prevalence</td>
<td>Smoked 100 cigarettes in lifetime and currently smoke every day or some days</td>
<td>Smoked 100 cigarettes in lifetime and currently smoke every day or some days</td>
<td>Current smoker recorded in structured smoking section**</td>
</tr>
<tr>
<td>Obesity</td>
<td>Prevalence</td>
<td>BMI≥30 from measured height and weight</td>
<td>BMI≥30 from self-reported height and weight</td>
<td>BMI≥30 from most recent height and weight* in vitals</td>
</tr>
<tr>
<td>Depression</td>
<td>Prevalence</td>
<td>Ever told bad depression or PHQ-9 score of 10-27</td>
<td>Ever told bad depression or PHQ-9 score of 10-27</td>
<td>Ever diagnosis of depression or ever PHQ-9 score of 10-27</td>
</tr>
<tr>
<td>Influenza vaccination</td>
<td>Prevalence</td>
<td>Self-reported receipt of influenza vaccination*</td>
<td>Self-reported receipt of influenza vaccination*</td>
<td>CVX, CPT or ICD-9 code indicating receipt of influenza vaccination*</td>
</tr>
</tbody>
</table>
## Indicator Definitions

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Type</th>
<th>NYC HANES</th>
<th>CHS</th>
<th>NYC Macroscope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension (HTN)</td>
<td>Prevalence of History/Diagnosis: Ever told had HTN</td>
<td>(n=1,133)</td>
<td>(n=6,165)</td>
<td>(n=716,075)</td>
</tr>
<tr>
<td></td>
<td>Total prevalence: HANES gold standard</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BP systolic≥140 or diastolic≥90 or ever told had HTN and currently taking medication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total prevalence: Augmented</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BP≥140/90 or ever told had HTN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Treatment</td>
<td>Medication prescribed* among ever told had HTN</td>
<td></td>
<td>Medication prescribed* among ever diagnosed HTN</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>BP&lt;140/90 among ever told had HTN</td>
<td></td>
<td>Most recent BP &lt;140/90* among ever diagnosed HTN</td>
</tr>
</tbody>
</table>
# Indicator Definitions

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Type</th>
<th>NYC HANES (n=1,135)</th>
<th>CHS (n=6,165)</th>
<th>NYC Macroce (n=716,078)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High cholesterol</td>
<td></td>
<td>Prevalence of History/Diagnosis: Ever told had high cholesterol</td>
<td>Ever told had high cholesterol</td>
<td>Ever diagnosis of high cholesterol</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total prevalence: HANES gold standard: Total cholesterol ( \geq 240 ) or ever told</td>
<td>Most recent total cholesterol ( \geq 240 ) or ever diagnosis of high</td>
<td>Most recent total cholesterol ( \geq 240 ) or ever diagnosis of high cholesterol</td>
</tr>
<tr>
<td></td>
<td></td>
<td>had high cholesterol and currently taking medication</td>
<td>cholesterol with medication prescribed</td>
<td>or medication prescribed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total prevalence: Augmented: Total cholesterol ( \geq 240 ) or ever told had</td>
<td>Most recent total cholesterol ( \geq 240 ) or ever diagnosis of high</td>
<td>Most recent total cholesterol ( \geq 240 ) or ever diagnosis of high cholesterol</td>
</tr>
<tr>
<td></td>
<td></td>
<td>high cholesterol</td>
<td>cholesterol or medication prescribed</td>
<td>or medication prescribed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Treatment: Medication prescribed among ever told had high cholesterol</td>
<td>Medication prescribed among ever diagnosed high cholesterol</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control: Total cholesterol ( &lt;240 ) among ever told had high cholesterol</td>
<td>Most recent total cholesterol ( &lt;240 ) among ever diagnosed with high</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>cholesterol</td>
<td></td>
</tr>
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</table>
## Indicator Definitions

<table>
<thead>
<tr>
<th>Indicator</th>
<th>NYC HANES</th>
<th>CHS</th>
<th>NYC Macroscope</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n=1,113)</td>
<td>(n=6,166)</td>
<td>(n=716,075)</td>
</tr>
<tr>
<td>Prevalence of History/Diagnosis</td>
<td>Ever told had DM</td>
<td>Ever told had DM</td>
<td>Ever diagnosed of DM</td>
</tr>
<tr>
<td>Total prevalence: Augmented A1c&gt;=6.5 or ever told had DM</td>
<td>Most recent A1c&gt;=6.5** or ever diagnosis of DM or medication prescribed*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td>Currently taking medication among ever told had DM</td>
<td>Medication prescribed* among ever diagnosed DM</td>
<td></td>
</tr>
<tr>
<td>Poor control</td>
<td>A1C &gt; 9 among ever told had DM</td>
<td>Most recent A1C&gt;9** among ever diagnosed DM</td>
<td></td>
</tr>
</tbody>
</table>

* In past calendar year  
** In past 2 calendar years  
*** For full list of treatment medication queried for hypertension, diabetes and cholesterol, see Appendix A