

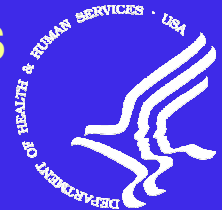
# Sodium Surveillance and Monitoring in NHANES

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES  
Centers for Disease Control and Prevention  
National Center for Health Statistics



# Outline for this presentation

- Sodium and blood pressure monitoring in NHANES
- Their importance as content in the survey
- Sodium biomarkers in NHANES
- Improvements in sodium monitoring and challenges for the future

# Sodium monitoring in NHANES

- Dietary intake data on sodium and potassium
- Blood pressure measurements
- Biomarker tests

# National Health and Nutrition Examination Surveys

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| <i>Survey</i> | <i>Dates</i> | <i>Ages</i>    |
|---------------|--------------|----------------|
| NHES I        | 1959-62      | 18-79 years    |
| NHES II       | 1963-65      | 6-11 years     |
| NHES III      | 1966-70      | 12-17 years    |
| NHANES I      | 1971-75      | 1-74 years     |
| NHANES II     | 1976-80      | 6 mo.-74 years |
| HHANES        | 1982-84      | 6 mo.-74 years |
| NHANES III    | 1988-94      | 2 mo. +        |

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# National Health and Nutrition Examination Surveys

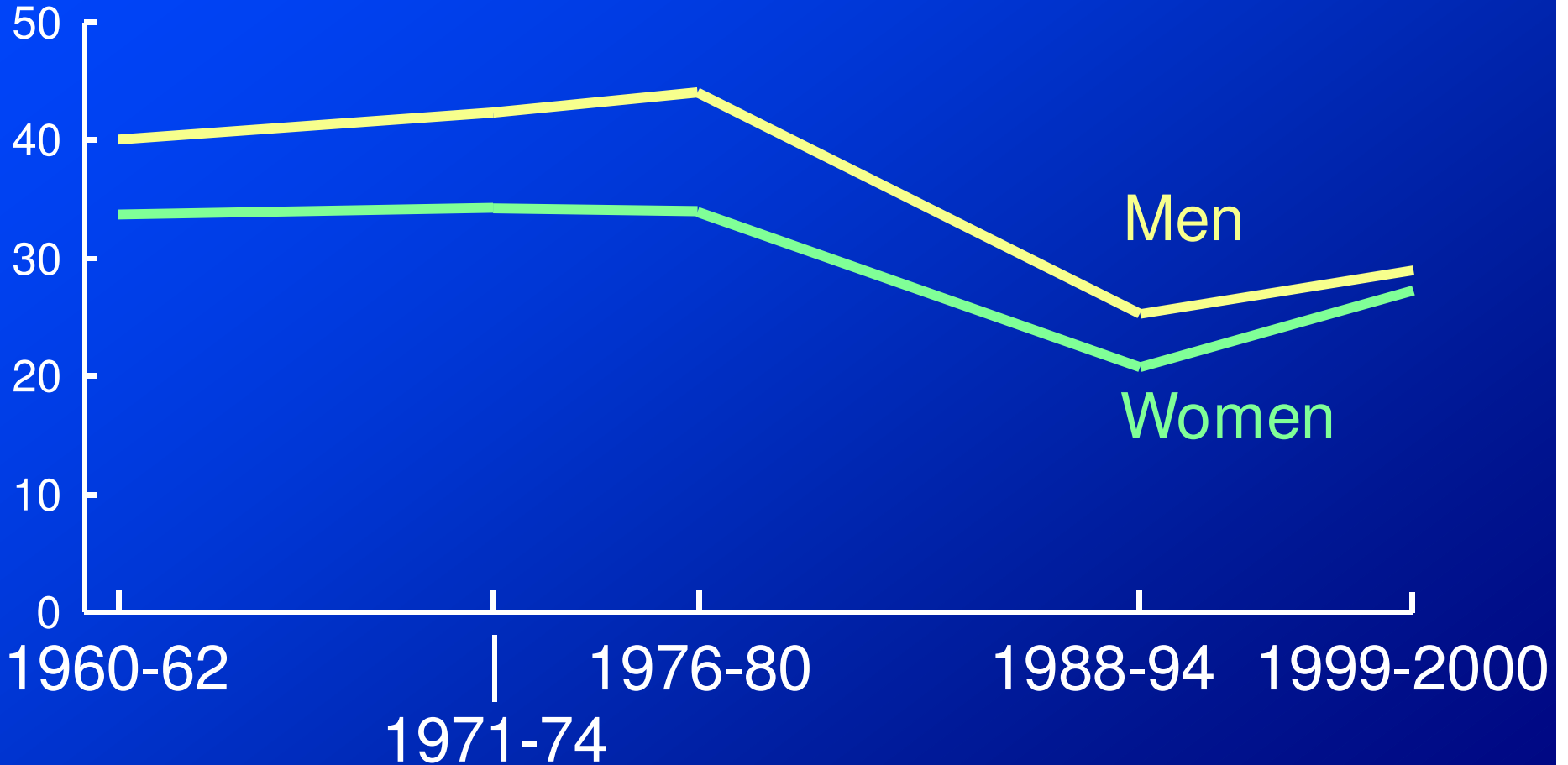
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| <i>Survey</i> | <i>Dates</i> | <i>Ages</i> |
|---------------|--------------|-------------|
| NHANES        | 1999-2000    | All ages    |
| NHANES        | 2001-2002    | All ages    |
| NHANES        | 2003-2004    | All ages    |
| NHANES        | 2005-2006    | All ages    |
| NHANES        | 2007-2008    | All ages    |
| NHANES        | 2009-2010    | All ages    |
| NHANES        | 2011-2012    | All ages    |

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# Hypertension, 1960-2000: Ages 20-74

Percent of population



## Age-Adjusted Prevalence of Hypertension in US adults, 1999-2006



SOURCE: Centers for Disease Control and Prevention, National Center for Health Statistics, National Health and Nutrition Examination Survey

## Trends of Elevated Blood Pressure Among Children and Adolescents: Data From the National Health and Nutrition Examination Survey 1988–2006

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### BACKGROUND

Elevated blood pressure (EBP) in children and adolescents increases future risk of cardiovascular disease. Among children and adolescents, increased weight is associated with EBP.

### METHODS

National cross-sectional data for children and adolescents aged 8–17 years from the National Health and Nutrition Examination Surveys (NHANES): 1988–1994, 1999–2002, and 2003–2006. The main outcome measures were EBP and pre-EBP estimates.

### RESULTS

Overweight boys (odds ratio (OR) 1.54, confidence interval (CI) 1.11–2.13) and both obese boys and girls were significantly more likely to be classified as pre-EBP (boys, OR 2.81, CI 2.13–3.71; girls, OR 2.55, CI 1.75–3.73) and having EBP (boys aged 8–12 years, OR 6.06, CI 2.73–13.44; boys aged 13–17, OR 9.62, CI 4.86–19.06; girls, OR 2.33, CI 1.31–4.13) when compared to the reference weight and controlling for all other covariates.

High blood pressure (BP), or hypertension, is a modifiable risk factor for cardiovascular disease.<sup>1</sup> Elevated BP (EBP) levels increase the risk of heart attack, heart failure, stroke, and kidney disease. Hypertension awareness followed by effective treatment and control measures can reduce morbidity and mortality associated with uncontrolled hypertension.<sup>2–5</sup> Although hypertension is more prevalent among adults than youths, recent population-based, prospective cohort studies have reported that BP levels measured in childhood and adolescence are also associated with elevated BP in adulthood.<sup>6–9</sup>

High body mass index (BMI) has been linked to elevated BP levels among youths and adults.<sup>10–12</sup> In 2003–2006, 17.0% of children aged 6–11 years old and 17.6% of children aged 12–19

During 2003–2006, 13.6% (s.e. = 1.2) of 5.7% (s.e. = 0.7) of the girls aged 8–17 and 2.6% (s.e. = 0.5) of the boys aged 8–17 were having EBP. A higher BMI, ethnicity, and body mass index (BMI) were more likely to have EBP during 2003–2006 (OR 2.17, CI 1.05–4.49). In contrast, adolescents were significantly less likely to be having EBP during 1988–1994 (OR 0.32, CI 0.13–0.81).

### CONCLUSIONS

Obesity is strongly, positively, and independently associated with EBP among youths. However, including BMI, EBP has increased among adolescent boys aged 13–17, during 2003–2006 compared with 1988–1994.

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had a BMI for age and gender at the 95th percentile or above in the United States increased from 1988–1994 to 2003–2006 (14). However, the most recent nationally significant trend in high BMI found over the time periods 1988–1994, 2004, and 2005–2006 ref. 13). Childhood overweight and the associated hypertension and increased cardiovascular risk in adulthood have implications for educational initiatives.<sup>8</sup>

We analyzed the data from the National Health and Nutrition Examination Surveys (NHANESs) conducted in 1988–1994, 1999–2002, and 2003–2006. Measured BP levels of youths were used. The objectives of the study were to estimate pre-EBP and EBP prevalence over time; and (2) to estimate the prevalence of EBP by age, gender, and race/ethnicity.

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### Trends of EBP Among Children and Adolescents

**Table 1 | Percent prevalence and standard error (s.e.) of pre-elevated BP<sup>a</sup> among children and adolescents aged 8 through 17 years: United States, NHANES 1988–1994, 1999–2002, and 2003–2006**

|  | 1988–1994 |                  |      | 1999–2002 |      |      | 2003–2006 |                  |      |
|--|-----------|------------------|------|-----------|------|------|-----------|------------------|------|
|  | N         | %                | s.e. | N         | %    | s.e. | N         | %                | s.e. |
| <b>Both genders and all race/ethnicities</b> |           |                  |      |           |      |      |           |                  |      |
| 8–17 years                                   | 4,033     | 7.3              | 0.8  | 4,846     | 9.1  | 0.6  | 4,427     | 9.7              | 0.8  |
| 8–12 years                                   | 2,235     | 3.0              | 0.8  | 1,984     | 4.3  | 0.7  | 1,808     | 5.5              | 1.0  |
| 13–17 years                                  | 1,798     | 11.6             | 1.2  | 2,862     | 13.9 | 0.8  | 2,619     | 13.6             | 1.0  |
| <b>Boys</b>                                  |           |                  |      |           |      |      |           |                  |      |
| 8–17 years                                   | 1,966     | 10.4             | 1.1  | 2,425     | 12.5 | 0.9  | 2,225     | 13.6             | 1.2  |
| 8–12 years                                   | 1,120     | 3.3              | 0.9  | 996       | 5.1  | 1.1  | 879       | 6.3              | 1.5  |
| 13–17 years                                  | 846       | 17.6             | 1.9  | 1,429     | 20.0 | 1.2  | 1,346     | 20.4             | 1.6  |
| <b>Girls</b>                                 |           |                  |      |           |      |      |           |                  |      |
| 8–17 years                                   | 2,067     | 4.1              | 0.9  | 2,421     | 5.6  | 0.7  | 2,202     | 5.7              | 0.7  |
| 8–12 years                                   | 1,115     | 2.7              | 0.8  | 988       | 3.4  | 0.6  | 929       | 4.5              | 0.9  |
| 13–17 years                                  | 952       | 5.5              | 1.3  | 1,433     | 7.6  | 1.1  | 1,273     | 6.8              | 0.9  |
| <b>Mexican American</b>                      |           |                  |      |           |      |      |           |                  |      |
| <b>Both genders</b>                          |           |                  |      |           |      |      |           |                  |      |
| 8–17 years                                   | 1,363     | 7.1              | 1.0  | 1,727     | 10.9 | 0.9  | 1,416     | 9.8              | 0.8  |
| 8–12 years                                   | 768       | 3.0              | 0.7  | 677       | 6.3  | 1.0  | 591       | 6.9              | 1.1  |
| 13–17 years                                  | 595       | 11.5             | 1.8  | 1,050     | 16.0 | 1.5  | 825       | 12.9             | 1.0  |
| <b>Boys</b>                                  |           |                  |      |           |      |      |           |                  |      |
| 8–17 years                                   | 665       | 10.3             | 1.9  | 871       | 15.5 | 1.5  | 704       | 13.2             | 1.4  |
| 8–12 years                                   | 376       | 3.7 <sup>b</sup> | 1.2  | 353       | 7.4  | 1.6  | 291       | 6.8              | 1.7  |
| 13–17 years                                  | 289       | 17.5             | 3.4  | 518       | 24.0 | 2.7  | 413       | 20.3             | 1.7  |
| <b>Girls</b>                                 |           |                  |      |           |      |      |           |                  |      |
| 8–17 years                                   | 698       | 4.0              | 0.8  | 856       | 5.8  | 0.6  | 712       | 6.0              | 0.9  |
| 8–12 years <sup>b</sup>                      | 392       | 2.4 <sup>b</sup> | 0.7  | 324       | 5.2  | 1.2  | 300       | 7.0              | 1.4  |
| 13–17 years                                  | 306       | 5.6              | 1.2  | 532       | 6.6  | 0.9  | 412       | 5.0              | 1.2  |
| <b>Non-Hispanic white</b>                    |           |                  |      |           |      |      |           |                  |      |
| <b>Both genders</b>                          |           |                  |      |           |      |      |           |                  |      |
| 8–17 years                                   | 1,073     | 7.4              | 1.1  | 1,226     | 8.6  | 0.8  | 1,163     | 9.6              | 1.1  |
| 8–12 years                                   | 579       | 3.1 <sup>d</sup> | 1.2  | 512       | 3.4  | 0.8  | 449       | 4.6 <sup>d</sup> | 1.6  |
| 13–17 years                                  | 494       | 11.6             | 1.5  | 714       | 13.7 | 1.2  | 714       | 13.6             | 1.4  |
| <b>Boys</b>                                  |           |                  |      |           |      |      |           |                  |      |
| 8–17 years                                   | 510       | 10.3             | 1.4  | 619       | 11.8 | 1.2  | 575       | 13.9             | 1.7  |
| 8–12 years                                   | 294       | 3.6 <sup>d</sup> | 1.4  | 263       | 4.3  | 1.5  | 216       | 5.9 <sup>d</sup> | 2.2  |
| 13–17 years                                  | 216       | 17.0             | 2.3  | 356       | 19.7 | 1.7  | 359       | 20.5             | 2.2  |
| <b>Girls</b>                                 |           |                  |      |           |      |      |           |                  |      |
| 8–17 years                                   | 563       | 4.4              | 1.1  | 607       | 6.8  | 1.0  | 588       | 6.1              | 1.0  |
| 8–12 years                                   | 283       | 2.7              | 0.9  | 249       | 3.8  | 1.1  | 233       | 4.2              | 1.3  |
| 13–17 years                                  | 270       | 14.3             | 1.9  | 443       | 16.6 | 1.5  | 435       | 16.5             | 1.6  |

<sup>a</sup>Pre-EBP is defined as systolic BP ≥ 130 mmHg or diastolic BP ≥ 85 mmHg. <sup>b</sup>Prevalence of EBP among Mexican American boys aged 8–12 years and non-Hispanic white girls aged 8–12 years was significantly lower than that among other groups (P < 0.05).

# Adjusted odds ratios for elevated BP

| <i>BMI Category</i>                    | <i>Boys 8-12 y</i>       | <i>Boys 13-17 y</i>      | <i>Girls 8-17 y</i>     |
|--|--------------------------|--------------------------|-------------------------|
| $\geq 5^{\text{th}} < 85^{\text{th}}$  | ref                      | ref                      | ref                     |
| $\geq 85^{\text{th}} < 95^{\text{th}}$ | 0.85 (0.33-2.18)         | 2.08 (0.79-5.46)         | 1.23 (0.56-2.74)        |
| $\geq 95^{\text{th}}$                  | <b>6.06 (2.73-13.44)</b> | <b>9.64 (4.86-19.06)</b> | <b>2.33 (1.31-4.13)</b> |

Source: Ostchega et al In Press AJH; Data from National Health and Nutrition Examination Surveys 88-94 and 1999-2002, 2003-2006, NCHS/CDC; adjusted for survey period, race/ethnicity and age group

NOTE: BP, blood pressure; BMI, body mass index category based on the percentiles in the CDC growth charts

# Sodium biomarkers in NHANES

- Sodium and potassium measured in our Standard Metabolic Assessment panel of lab tests
- No 24-hour urinary excretion assessment

# Improvements for Sodium monitoring in NHANES

- Multiple days of dietary intake data and expanded questions on knowledge and behavior
- Improved quality of blood pressure measurements
- More timely data release

# Challenges for Sodium monitoring in NHANES

- Resources to maintain the current amount of data collected
- How to implement 24-hour urinary excretion collection in the survey
- Logistics, costs and response rates for such a component in NHANES

# NHANES turns 50!





<http://www.cdc.gov/nchs/nhanes.htm>