2022 Add Health Users Conference

Add Health Wave V Biological Data and Vital Events

Tuesday July 12, 2022
10:15-11:45 AM

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Add Health Wave V

• Biological Data
• Vital Events
Wave V Biological Data – Choice

• Conditions prevalent among young-to-middle aged U.S. adults
• Processes by which they are associated with future health
• Measures characterizing those processes
• Feasibility of field collection across U.S.
• Availability of data across waves
• Reliability & validity of results
Wave V Biological Data – Domains

• Cardiovascular
• Anthropometric
• Metabolic
• Inflammatory
• Renal
• Omic
• Pharmacologic
• Other
## Wave V Biological Data – Measures

| Biological Data Domains and Measures | \( \text{SBP} \) [mmHg] | \( \text{DBP} \) [mmHg] | \( \text{PR} \) [beats/min] | \( \text{Weight} \) [kg] | \( \text{Height} \) [cm] | \( \text{Waist Circumference} \) [cm] | \( \text{Arm Circumference} \) [cm] | \( \text{HbA1c} \) [%] | \( \text{Glucose} \) [mg/dL] | \( \text{TC} \) [mg/dL] | \( \text{HDL-C} \) [mg/dL] | \( \text{TG} \) [mg/dL] | \( \text{hsCRP} \) [mg/L] | \( \text{Creatinine} \) [mg/dL] | \( \text{Cystatin C} \) [mg/L] | \( \text{Transcriptome} \) | \( \text{Microbiome} \) | \( \text{Epigenome} \) | \( \text{Medication Use} \) |
|-------------------------------------|---------------------------|---------------------------|-----------------------------|--------------------------|-------------------------|----------------------------------|----------------------------------|-----------------|--------------------------|----------------|---------------------|----------------|---------------------|----------------|---------------------|----------------|
| Cardiovascular                      |                           |                           |                             |                           |                         |                                  |                                  |                 |                          |                |                     |                |                     |
| Anthropometric                      |                           |                           |                             |                           |                         |                                  |                                  |                 |                          |                |                     |                |                     |
| Metabolic                           |                           |                           |                             |                           |                         |                                  |                                  |                 |                          |                |                     |                |                     |
| Inflammatory                        |                           |                           |                             |                           |                         |                                  |                                  |                 |                          |                |                     |                |                     |
| Renal                               |                           |                           |                             |                           |                         |                                  |                                  |                 |                          |                |                     |                |                     |
| Omic                                |                           |                           |                             |                           |                         |                                  |                                  |                 |                          |                |                     |                |                     |
| Pharmacologic                       |                           |                           |                             |                           |                         |                                  |                                  |                 |                          |                |                     |                |                     |

\( \text{DBP} = \text{diastolic blood pressure} \)  \( \text{HbA1c} = \text{hemoglobin A1c} \)  \( \text{HDL-C} = \text{high-density lipoprotein cholesterol} \)  \( \text{PR} = \text{pulse rate} \)  \( \text{SBP} = \text{systolic blood pressure} \)  \( \text{TC} = \text{total cholesterol} \)  \( \text{TG} = \text{triglycerides} \)
Wave V Biological Data – Measures

• Cardiovascular
  • Primary
    • systolic blood pressure (SBP)
    • diastolic blood pressure (DBP)
    • pulse rate (PR)
  • Secondary
    • pulse pressure (PP = SBP – DBP)
    • mean arterial pressure (MAP = [SBP + 2 × DBP] ÷ 3)
Wave V Biological Data – Classification

• Cardiovascular
  • SBP/DBP according to JNC 7 guidelines*
    - < 120/80 mm Hg  Normal
    - 120-139/80-89 mm Hg  Pre-Hypertension
    - 140-159/90-99 mm Hg  Stage 1 Hypertension
    - ≥ 160/100 mm Hg  Stage 2 Hypertension
  • SBP/DBP according to ACC/AHA guidelines†
    - < 120/80 mm Hg  Normal
    - 120-129/<80 mm Hg  Elevated
    - 130-139/80-89 mm Hg  Stage 1 Hypertension
    - ≥ 140/90 mm Hg  Stage 2 Hypertension

Wave V Biological Data – Measures

• Anthropometric
  • Primary
    • weight
    • height
    • waist circumference (waist)
    • arm circumference (arm)
  • Secondary
    • body mass index (BMI = weight in kg / height in m^2)
Wave V Biological Data – Classification

• **Anthropometric**
  - Waist according to NHLBI Evidence Report*
    - \( \leq 88 \text{ (102) cm in } \♀ (\♂) \) Lower Risk
    - > 88 (102) cm in \( \♀ (\♂) \) High Risk
  - BMI according to NHLBI Evidence Report*
    - < 18.5 kg/m\(^2\) Underweight
    - 18.5-24.9 kg/m\(^2\) Normal
    - 25.0-25.9 kg/m\(^2\) Overweight
    - 30.0-34.9 kg/m\(^2\) Obesity, Stage I
    - 35.0-39.9 kg/m\(^2\) Obesity, Stage II
    - \( \geq 40.0 \text{ kg/m}^2 \) Obesity, Stage III

*Obesity Res 1998;6(S2);51S-210S.
Wave V Biological Data – Measures

• Metabolic, lipids*
  • Primary
    • total cholesterol (TC)
    • high density lipoprotein cholesterol (HDL-C)
    • triglycerides (TG)
  • Secondary
    • low density lipoprotein cholesterol (LDL-C = TC - HDL-C - TG ÷ 5)†
    • TC:HDL-C ratio (= TC / HDL-C)
    • non-HDL-C (= TC - HDL-C)

*Fasting or non-fasting. †Estimated using the Friedwald equation when TG < 400 mg/dl Directly assayed when TG ≥ 400 mg/dl. Clin Chem 1972;18(6):499.
Wave V Biological Data – Classification

• Metabolic, lipids*

• According to NCEP ATP III guidelines†
  • TC (mg/dl)
    - < 200 desirable
    - 200-239 borderline high
    - ≥ 240 high
  • HDL-C (mg/dl)
    - < 40 low
    - ≥ 60 high
  • LDL-C (mg/dl)
    - < 100 optimal
    - 100-129 near optimal
    - 130-159 borderline high
    - 160-189 high
    - ≥ 190 very high
  • TG‡ (mg/dl)
    - < 150 normal
    - 150-199 borderline high
    - 200-499 high
    - ≥ 500 very high

• According to AHA/ACC guidelines‖
  • LDL-C (mg/dl)
    - 160-189 moderate
    - ≥ 190 severe hypercholesterolemia
  • TG‡ (mg/dl)
    - 175-499 moderate
    - ≥ 500 severe hypertriglyceridemia

*Fasting. †Circulation 2002;106(25):3143. ‡Spuriously high in the non-fasting state. ‖JACC 2018. pii:S0735-1097(18)39034-X.
Wave V Biological Data – Measures

- Metabolic, glucose homeostasis*
  - glucose
  - glycosylated hemoglobin (HbA1c)
Wave V Biological Data – Classification

• Metabolic, glucose homeostasis*
  • According to ADA guidelines†
    • fasting glucose (mg/dl)
      ≤ 99 normal
      100-125 impaired
      ≥ 126 diabetes
    • non-fasting glucose (mg/dl)
      ≥ 200 diabetes
    • HbA1c (%)
      5.7-6.4 increased risk for diabetes
      ≥ 6.5 diabetes

*Fasting or non-fasting. Diabetes Care 2019;42(S1):S13.
Wave V Biological Data – Measures

• Inflammatory
  • high sensitivity C-reactive protein (hsCRP)
Wave V Biological Data – Classification

• Inflammatory
  • hsCRP according to CDC / AHA guidelines*
    < 1 mg/L low
    1-3 mg/L average
    > 3 mg/L high
    > 10 mg/L must trigger searches for factors capable of confounding hsCRP-based risk estimates
Wave V Biological Data – Measures

- Renal
  - Primary
    - creatinine
    - cystatin c
  - Secondary
    - estimated glomerular filtration rate (eGFR in ml/min/1.73 m\(^2\))*
      \[= 141 \times \min(\text{Scr}/\kappa, 1)\alpha \times \max(\text{Scr}/\kappa, 1)^{-1.209} \times 0.993^{\text{Age}[\times 1.018 \text{ if } \varphi]} \times 1.159 \text{ if black}],\]
      where:
      \[
      \begin{align*}
      \text{Scr} &= \text{serum creatinine} \\
      \kappa &= 0.7 (\varphi) \text{ or } 0.9 (\varrho) \\
      \alpha &= -0.329 (\varphi) \text{ or } -0.411 (\varrho)
      \end{align*}
      \]
  - analogous formulas for Scys & Scr-cys
  - newer NKF/ASN-endorsed equations include both, omit race & are most accurate

Wave V Biological Data – Classification

• Renal
  • eGFR according to KDIGO guidelines*
    - ≥90 ml/min/1.73 m²  Normal or high (G1)
    - 60-89          Mildly decreased (G2)*
    - 45-59          Mildly to moderately decreased (G3a)
    - 30-44          Moderately to severely decreased (G3b)
    - 15-29          Severely decreased (G4)
    - <15           Kidney failure (G5)

Wave V Biological Data – Measures

• Pharmacologic
  • prescription medications
  • select over-the-counter medications (salicylates & NSAIDS)
Wave V Biological Data – Classification

• Pharmacologic
  • prescriptions according to Multum Lexicon Plus®
  • example therapeutic classes
    • antihypertensives
    • antihyperlipidemics
    • antidiabetics
    • anti-inflammatories
    • narcotics
    • antidepressants
    • antipsychotics
    • anxiolytics
    • anticonvulsants
Wave V Biological Data – Measures

• Other
  • Additional Inflammatory/Immune
    • IL-1B, 6, 8 & 10
    • Tumor Necrosis Factor (TNF-α)
    • Cytomegalovirus (CMV)
  • Hepatic
    • Aspartate Aminotransferase (AST)
    • Alanine Aminotransferase (ALT)
    • AST:ALT Ratio
  • Neurodegeneration
    • Neurofilament Light Chain (NfL)
    • Tau
Wave V Biological Data – Collection

• Scheduling
• Preparation
• Interview
• Examination
• Medication Inventory
• Phlebotomy
• Processing
• Data Upload
Wave V Biological Data – Collection

- Scheduling
## Wave V Biological Data – Collection

### Scheduling

<table>
<thead>
<tr>
<th></th>
<th>Sunday</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning</td>
<td>✔</td>
<td>✔*</td>
<td>✔</td>
<td>✔*</td>
<td>✔*</td>
<td>✔</td>
<td>✗</td>
</tr>
<tr>
<td>Afternoon</td>
<td>✔</td>
<td>✔*</td>
<td>✔</td>
<td>✔*</td>
<td>✔</td>
<td>✔</td>
<td>✗</td>
</tr>
<tr>
<td>Evening</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
</tbody>
</table>

- ✔ Preferred – if able to meet *same day* FedEx cutoff
- ✔* Acceptable – if able to meet *next day* FedEx cutoff
- ✗ Not Acceptable
Wave V Biological Data – Collection

• Preparation

<table>
<thead>
<tr>
<th>Home visit equipment and supply list</th>
<th>Prepackaged home visit kit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photo ID Badge</td>
<td>Vacutainer holder</td>
</tr>
<tr>
<td>Samsung Galaxy 4 Tablet with power cord</td>
<td>21 gauge needle</td>
</tr>
<tr>
<td>MicroLife blood pressure unit with medium and large cuff</td>
<td>Nitrile gloves</td>
</tr>
<tr>
<td>Spare batteries for blood pressure unit (4 X AA)</td>
<td>2” x 2” gauze pad</td>
</tr>
<tr>
<td>SECA circumferential tape measure</td>
<td>Bandage</td>
</tr>
<tr>
<td>Metal tape measure</td>
<td>Tourniquet</td>
</tr>
<tr>
<td>Carpenter’s square</td>
<td>5 or 6 Vacutainer tubes ***</td>
</tr>
<tr>
<td>Health-o-Meter weight scale</td>
<td>Biohazard Ziploc bag</td>
</tr>
<tr>
<td>Spare batteries for Health-o-Meter scale (2 X CR2032)</td>
<td>Alcohol prep pad</td>
</tr>
<tr>
<td>Cooler/ice packs for cooling samples until centrifugation</td>
<td>Pipettes</td>
</tr>
<tr>
<td>Job Aid Documents</td>
<td>Transport tubes</td>
</tr>
<tr>
<td>Pens and Sharpsies</td>
<td>4 Loose Barcode Labels [for shipping manifest, paper version of questionnaire (if needed), glucose transport tube (if needed), and one extra]</td>
</tr>
<tr>
<td>EMSI supplied respondent contact and information sheet</td>
<td>FedEx mailing pouch</td>
</tr>
<tr>
<td>Pre-printed Post-It notes</td>
<td></td>
</tr>
<tr>
<td>Biohazard bag</td>
<td></td>
</tr>
<tr>
<td>Cardiovascular Health Fact Sheet</td>
<td></td>
</tr>
<tr>
<td>Respondent Fact Sheet</td>
<td></td>
</tr>
<tr>
<td>Protective cover (Clax) for table top (examiner supplied)</td>
<td></td>
</tr>
<tr>
<td>Sharps Container (examiner supplied)</td>
<td></td>
</tr>
</tbody>
</table>
Wave V Biological Data – Collection

• Interview & Examination
  • Relied on a Samsung Tablet to
    • guide interview & exam
    • record self-reported health status
    • record physical measurements
    • tailor follow-up recommendations
    • inventory / code medications
    • guide biospecimen processing & shipping
    • control data quality (range checks; double entry)
    • transmit data
# Wave V Biological Data – Collection

- **Examination**
  - **Cardiovascular equipment**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Equipment</th>
<th>Pictures</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arm</td>
<td>Seca 200</td>
<td></td>
<td>200 cm maximum</td>
</tr>
<tr>
<td>Circumference</td>
<td>2-sided cm scaling</td>
<td></td>
<td>2-sided cm scaling</td>
</tr>
<tr>
<td>Tape</td>
<td>1 mm graduations</td>
<td></td>
<td>1 mm graduations</td>
</tr>
<tr>
<td>Measure</td>
<td>fiberglass tape</td>
<td></td>
<td>fiberglass tape</td>
</tr>
<tr>
<td></td>
<td>Add Health-validated*</td>
<td></td>
<td>Add Health-validated*</td>
</tr>
<tr>
<td></td>
<td>plastic case</td>
<td></td>
<td>plastic case</td>
</tr>
<tr>
<td></td>
<td>automatic roll-up</td>
<td></td>
<td>automatic roll-up</td>
</tr>
<tr>
<td></td>
<td>end-peg positioner</td>
<td></td>
<td>end-peg positioner</td>
</tr>
<tr>
<td></td>
<td>90 x 25 x 65 mm</td>
<td></td>
<td>90 x 25 x 65 mm</td>
</tr>
<tr>
<td></td>
<td>50 g</td>
<td></td>
<td>50 g</td>
</tr>
<tr>
<td></td>
<td>&lt; $13</td>
<td></td>
<td>&lt; $13</td>
</tr>
</tbody>
</table>

Wave V Biological Data – Collection

- Examination
  - Cardiovascular equipment

<table>
<thead>
<tr>
<th>Measures</th>
<th>Equipment</th>
<th>Picture</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBP</td>
<td>MicroLife</td>
<td></td>
<td>30-280/40-200 BP/PR range</td>
</tr>
<tr>
<td>DBP</td>
<td>3MC1-PC_IB</td>
<td></td>
<td>1-unit graduations</td>
</tr>
<tr>
<td>PR</td>
<td>Oscillometric</td>
<td></td>
<td>198 measure recall</td>
</tr>
<tr>
<td></td>
<td>BP</td>
<td></td>
<td>± 3 mmHg accuracy</td>
</tr>
<tr>
<td></td>
<td>Monitor</td>
<td></td>
<td>± 5 beat pulse accuracy</td>
</tr>
<tr>
<td></td>
<td>Add Health</td>
<td></td>
<td>BHS-approved</td>
</tr>
<tr>
<td></td>
<td>validated*</td>
<td></td>
<td>Add Health-validated*</td>
</tr>
<tr>
<td></td>
<td>“AA” battery</td>
<td></td>
<td>4 &quot;AA&quot; battery-powered</td>
</tr>
<tr>
<td></td>
<td>powered</td>
<td></td>
<td>w/ AC adapter + USB cable</td>
</tr>
<tr>
<td></td>
<td>w/ AC adapter</td>
<td></td>
<td>2 cuffs (24-41 cm)</td>
</tr>
<tr>
<td></td>
<td>+ USB cable</td>
<td></td>
<td>160 x 140 x 98 mm</td>
</tr>
<tr>
<td></td>
<td>4 &quot;AA&quot; battery</td>
<td></td>
<td>735 g (w/ batteries)</td>
</tr>
<tr>
<td></td>
<td>Add Health</td>
<td></td>
<td>&lt; $65</td>
</tr>
</tbody>
</table>

Wave V Biological Data – Collection

• Examination
  • Cardiovascular protocol*
    • trained, certified staff
    • resting, seated respondents
    • arm @ level of heart
    • cuff matched to arm circumference
    • measured SBP, DBP & PR
      • - 3x @ 30 sec intervals
      • - double entered
      • - automatically averaged over last 2
    • provide results, follow-up recs

Wave V Biological Data – Collection

- Examination
  - Anthropometric equipment

<table>
<thead>
<tr>
<th>Measure</th>
<th>Equipment</th>
<th>Pictures</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>Carpenter’s Square</td>
<td></td>
<td>portable</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>light weight</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>inexpensive</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>true 90° angle</td>
</tr>
<tr>
<td>Tape</td>
<td>Measure</td>
<td></td>
<td>10 ft</td>
</tr>
<tr>
<td>Post-it</td>
<td>Notes</td>
<td></td>
<td>steel tape</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>adherent</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>pre-labeled</td>
</tr>
</tbody>
</table>
Wave V Biological Data – Collection

• Examination
• Anthropometric equipment

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<th>Measure</th>
<th>Equipment</th>
<th>Pictures</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>Health-O-Meter 844KL High</td>
<td></td>
<td>4-point load cell</td>
</tr>
<tr>
<td></td>
<td>Capacity Digital Scale</td>
<td></td>
<td>digital display in lb / kg</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>440 lb maximum</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>0.1 lb graduations</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Add Health-validated*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>long life Li++ battery</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>low battery warning</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1-year warranty</td>
</tr>
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<td></td>
<td></td>
<td>12.6 x 12.6 in</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4.5 lb</td>
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<tr>
<td></td>
<td></td>
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<td>&lt; $70</td>
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</table>

Wave V Biological Data – Collection

• Examination
  • Anthropometric equipment

<table>
<thead>
<tr>
<th>Measure</th>
<th>Equipment</th>
<th>Pictures</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Arm</td>
<td>Seca 200</td>
<td></td>
<td>200 cm maximum</td>
</tr>
<tr>
<td>Circumference</td>
<td></td>
<td></td>
<td>2-sided cm scaling</td>
</tr>
<tr>
<td>Tape Measure</td>
<td></td>
<td></td>
<td>1 mm graduations</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>fiberglass tape</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Add Health-validated*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>plastic case</td>
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<td>automatic roll-up</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>&lt; $13</td>
</tr>
</tbody>
</table>

Wave V Biological Data – Collection

• Examination
  • Anthropometric protocol
    • trained, certified staff
    • dressed, unshoed respondents
    • standing on uncarpeted floor
    • measured
      • height to nearest 0.5 cm
      • weight to nearest 0.1 kg
      • waist to nearest 0.5 cm
        @ superior border of iliac crest
        @ end expiration
        horizontal to floor
      • hair/shoe height to nearest 0.5 cm, as needed
Wave V Biological Data – Collection

- Medication Inventory
- Protocol

Start Inventory  Enter Meds  Enter Sources
Wave V Biological Data – Collection

**NEW!**

**Phlebotomy & Processing**
- trained, certified phlebotomists
- fasting (ideally) respondents
- draw blood
- centrifuge
- package
- ship
- assay @ LCBR
- return results
Wave V Biological Data – Key Results

• Overall
  • Surveyed 12,300
  • Consented 8,379 (68%)
  • Examined 5,381 (64%)
Wave V Biological Data – Key Results

- Overall (unweighted)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>P25</th>
<th>P50</th>
<th>P75</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visits / Day</td>
<td>8.1</td>
<td>6.7</td>
<td>3.0</td>
<td>6.0</td>
<td>12.0</td>
</tr>
<tr>
<td>Start Time (0-23)</td>
<td>11.1</td>
<td>3.2</td>
<td>8.9</td>
<td>10.1</td>
<td>12.7</td>
</tr>
<tr>
<td>Duration (min)</td>
<td>37.8</td>
<td>18.2</td>
<td>28.0</td>
<td>35.0</td>
<td>44.3</td>
</tr>
<tr>
<td>Fasting (hr)</td>
<td>9.5</td>
<td>5.9</td>
<td>3.6</td>
<td>11.2</td>
<td>13.7</td>
</tr>
</tbody>
</table>
Wave V Biological Data – Key Results

• Cardiovascular (unweighted)

- 49% ≥ 130/80 (Stage 1)
- 19% ≥ 140/90 (Stage 2)
- 9% ≤ 60 (Bradycardia)
- 3% ≥ 100 (Tachycardia)
Wave V Biological Data – Key Results

- Anthropometric (unweighted)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>P25</th>
<th>P50</th>
<th>P75</th>
<th>P90</th>
<th>P95</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waist (cm)</td>
<td>97.7</td>
<td>19.0</td>
<td>84.0</td>
<td>96.0</td>
<td>109.0</td>
<td>123.0</td>
<td>133.0</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>30.7</td>
<td>7.8</td>
<td>24.9</td>
<td>29.2</td>
<td>34.7</td>
<td>41.2</td>
<td>45.9</td>
</tr>
</tbody>
</table>

51% > 88♀ or 102♂ (High Risk)
75% > 25 (Overweight or Obese)
Wave V Biological Data – Key Results

• Metabolic (unweighted)

- 3.9% ≥ 126 or 200 (Diabetes)
- 4.6% ≥ 6.5 (Diabetes)
- 5.1% ≥ 160 (Hypercholesterolemia)
- 20% ≥ 175 (Hypertriglyceridemia)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>P25</th>
<th>P50</th>
<th>P75</th>
<th>P90</th>
<th>P95</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glucose (mg/dl)</td>
<td>95</td>
<td>36</td>
<td>82</td>
<td>89</td>
<td>97</td>
<td>110</td>
<td>132</td>
</tr>
<tr>
<td>HbA1c (%)</td>
<td>5.4</td>
<td>0.9</td>
<td>5.0</td>
<td>5.2</td>
<td>5.4</td>
<td>5.7</td>
<td>6.3</td>
</tr>
<tr>
<td>TC (mg/dl)</td>
<td>181</td>
<td>36</td>
<td>156</td>
<td>177</td>
<td>202</td>
<td>227</td>
<td>242</td>
</tr>
<tr>
<td>HDL-C (mg/dl)</td>
<td>50</td>
<td>15</td>
<td>39</td>
<td>47</td>
<td>58</td>
<td>70</td>
<td>78</td>
</tr>
<tr>
<td>LDL-C (mg/dl)</td>
<td>106</td>
<td>32</td>
<td>84</td>
<td>103</td>
<td>125</td>
<td>146</td>
<td>160</td>
</tr>
<tr>
<td>TG (mg/dl)</td>
<td>129</td>
<td>95</td>
<td>71</td>
<td>102</td>
<td>156</td>
<td>237</td>
<td>298</td>
</tr>
</tbody>
</table>
Wave V Biological Data – Key Results

- Inflammatory & Renal

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>P25</th>
<th>P50</th>
<th>P75</th>
<th>P90</th>
<th>P95</th>
</tr>
</thead>
<tbody>
<tr>
<td>hsCRP (mg/L)</td>
<td>4.1</td>
<td>6.3</td>
<td>0.8</td>
<td>1.8</td>
<td>4.7</td>
<td>9.8</td>
<td>16</td>
</tr>
<tr>
<td>Creatinine (mg/dl)</td>
<td>0.8</td>
<td>0.4</td>
<td>0.7</td>
<td>0.8</td>
<td>0.9</td>
<td>1.1</td>
<td>1.2</td>
</tr>
<tr>
<td>GFR (ml/min/1.73m²)</td>
<td>104</td>
<td>16</td>
<td>77</td>
<td>83</td>
<td>94</td>
<td>106</td>
<td>113</td>
</tr>
</tbody>
</table>

- 20% > 3 (High)
- 19% < 90 (Decreased)
- 0.7% < 60 (CKD or ESKD)
Wave V Biological Data – Key Results

• Pharmacologic
  • Prescription medication use, by therapeutic class
    • antihypertensives 12.1%
    • antihyperlipidemics 3.8%
    • antidiabetics 4.8%
    • NSAID/salicylate 5.5%
Wave V Biological Data – Key Results

• Other
  • Inflammatory/Immune
  • Hepatic
  • Neurodegeneration

Pending!
Wave V Biological Data – Quality

• Threats
  • poorly trained or monitored staff
  • departures from standardized protocol
  • use of heterogeneous, untested equipment
  • reliance on manual processes
  • missing data
  • measurement error
    • trend / cyclicity
    • digit preference
    • inaccuracy
    • unreliability
Wave V Biological Data – Quality

• Control
  • uniformly train & monitor staff
  • follow standardized protocol
  • use standard, tested equipment
  • automate processes
  • track / reduce missing data
  • track / reduce measurement error
    • trend / cyclicity
    • digit preference
    • inaccuracy
    • unreliability
## Wave V Biological Data – Quality

- **Reliability**

<table>
<thead>
<tr>
<th>Race / Ethnicity</th>
<th>Sex</th>
<th>Intra-Individual Variation Sub-Study*</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>Male</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>12</td>
</tr>
<tr>
<td>Black</td>
<td>Male</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>12</td>
</tr>
<tr>
<td>Hispanic</td>
<td>Male</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>12</td>
</tr>
<tr>
<td>Other</td>
<td>Male</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>96</strong></td>
</tr>
</tbody>
</table>

*Involved examining participants 2x, 1-3 weeks apart, on ~ same day of week @ same time of day.*
Wave V Biological Data – Quality

• Reliability

<table>
<thead>
<tr>
<th>MEASURE</th>
<th>N</th>
<th>ICC</th>
<th>(95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBP23</td>
<td>112</td>
<td>0.72</td>
<td>(0.64, 0.81)</td>
</tr>
<tr>
<td>DBP23</td>
<td>112</td>
<td>0.71</td>
<td>(0.62, 0.80)</td>
</tr>
<tr>
<td>PR23</td>
<td>112</td>
<td>0.72</td>
<td>(0.63, 0.81)</td>
</tr>
<tr>
<td>Arm</td>
<td>112</td>
<td>0.86</td>
<td>(0.82, 0.91)</td>
</tr>
<tr>
<td>Height</td>
<td>110</td>
<td>0.95</td>
<td>(0.93, 0.97)</td>
</tr>
<tr>
<td>Weight</td>
<td>110</td>
<td>1</td>
<td>(1.00, 1.00)</td>
</tr>
<tr>
<td>Waist</td>
<td>109</td>
<td>0.96</td>
<td>(0.94, 0.97)</td>
</tr>
<tr>
<td>BMI</td>
<td>110</td>
<td>0.98</td>
<td>(0.98, 0.99)</td>
</tr>
<tr>
<td>GLUCOSE</td>
<td>103</td>
<td>0.94</td>
<td>(0.91, 0.96)</td>
</tr>
<tr>
<td>HBA1C</td>
<td>101</td>
<td>0.99</td>
<td>(0.99, 0.99)</td>
</tr>
<tr>
<td>TG</td>
<td>103</td>
<td>0.63</td>
<td>(0.51, 0.74)</td>
</tr>
<tr>
<td>TC</td>
<td>103</td>
<td>0.88</td>
<td>(0.84, 0.92)</td>
</tr>
<tr>
<td>HDL-C</td>
<td>103</td>
<td>0.95</td>
<td>(0.94, 0.97)</td>
</tr>
<tr>
<td>LDL-C</td>
<td>103</td>
<td>0.86</td>
<td>(0.81, 0.91)</td>
</tr>
<tr>
<td>HSCR</td>
<td>94</td>
<td>0.82</td>
<td>(0.75, 0.89)</td>
</tr>
<tr>
<td>CREATININE</td>
<td>103</td>
<td>0.93</td>
<td>(0.91, 0.96)</td>
</tr>
<tr>
<td>CYSTATIN-C</td>
<td>103</td>
<td>0.86</td>
<td>(0.81, 0.91)</td>
</tr>
<tr>
<td>GFR</td>
<td>103</td>
<td>0.89</td>
<td>(0.85, 0.93)</td>
</tr>
</tbody>
</table>

*The corresponding agreement (95% CI) between therapeutic classified prescription medications = 85% (79%-92%), kappa coefficient (95% CI) = 0.82 (0.71-0.93).
Wave V Vital Events
Wave V Vital Events

• Rationale

• Surveillance
  • Tracing, Screening & Matching
  • Investigation & Abstraction
  • Review, Classification & Adjudication

• Results

• Quality
Wave V Vital Events – Rationale

Risk Factor Distributions @ Wave IV

Epidemiology 2011;22(4):532.
Wave V Vital Events - Goal

• To establish a scalable infrastructure for surveillance of chronic disease events, initially by ascertaining decedents
• To anticipate the epidemiologic transition to rapid increases in chronic disease morbidity and mortality with age
• To do so under “The Biology of Chronic Disease Emergence and Medical Outcomes Surveillance” (Wave V Project 5096; P01-HD031921)
Wave V Vital Events – Surveillance

1. Trace, Screen & Match
   - Add Health Cohort
   - RTI Tracking
   - MOC Investigation
   - Deceased or Unlocatable
   - MOC Screening
   - Well-Identified Cases
   - NDI Matching
   - Matched Cases (1:1+)
   - CPC Scoring
   - Matched Cases (1:1)

2. Investigate & Abstract
   - Cohort History (All Deaths)
   - Obituary (All Deaths)
   - Death Certificate (All Deaths)
   - Healthcare Provider Q (Deaths w/ HCP)
   - Coroner/ME Report (Majority of Deaths)
   - Next-of-Kin Interview (Out-of-Hospital Deaths)
   - Hospital Records (In-Hospital Deaths)

3. Review, Classify & Adjudicate
   - MOC Abstraction
   - MD #1 Review, Initial Classification
     - CVD Outcomes
     - Causes of Death
   - MD Adjudication
     - Final Classification of CVD Outcomes and Causes of Death
   - MD #2 Review, Initial Classification
     - CVD Outcomes
     - Causes of Death
Wave V Vital Events – Results

• Tracing, Screening & Matching

640 of 641 Decedents Matched 1:1
NDI 1994-2020 & 2021 (preliminary)
Wave V Vital Events – Results

- Tracing, Screening & Matching
- Geographic Distribution of Deaths

Source: NDI, 1995-2021
Wave V Vital Events – Results

• Tracing, Screening & Matching
  • Temporal Distribution of Deaths
Wave V Vital Events – Results

• Tracing, Screening & Matching

• Demographic Distribution of Deaths

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean (Range) or %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>32.3 (14-46)</td>
</tr>
<tr>
<td>Female</td>
<td>37%</td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td></td>
</tr>
<tr>
<td>EA</td>
<td>53%</td>
</tr>
<tr>
<td>AA</td>
<td>25%</td>
</tr>
<tr>
<td>HL</td>
<td>12%</td>
</tr>
<tr>
<td>A/PI</td>
<td>5%</td>
</tr>
<tr>
<td>Al/AN</td>
<td>3%</td>
</tr>
<tr>
<td>O/M</td>
<td>2%</td>
</tr>
</tbody>
</table>

AA = African American. Al/AN = American Indian/Alaskan Native. A/PI = Asian/Pacific Islander. EA = European American. HL = Hispanic/Latino. O/M = Other/Multiple.
Wave V Vital Events – Results

• Investigation & Abstraction

Matched Cases (1:1)

- Cohort History (All Deaths)
- Obituary (All Deaths)
- Death Certificate (All Deaths)
- Healthcare Provider Q (Deaths w/ HCP)
- Coroner/ME Report (Majority of Deaths)
- Next-of-Kin Interview (Out-of-Hospital Deaths)
- Hospital Records (In-Hospital Deaths)

Executed Add Health-State* Agreements to Provide Death Certificates

Number

Date

Add Health
The National Longitudinal Study of Adolescents to Adult Health

UNC CAROLINA POPULATION CENTER

Wave V Vital Events – Results

- Investigation & Abstraction
  - Abstracted Records
Wave V Vital Events – Results

- Investigation & Abstraction
- Quality Control

<table>
<thead>
<tr>
<th>Abstraction Form</th>
<th>Agreement</th>
<th>Kappa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obituary</td>
<td>0.86 (0.84-0.89)</td>
<td>0.83 (0.80-0.86)</td>
</tr>
<tr>
<td>Death Certificate</td>
<td>0.93 (0.92-0.95)</td>
<td>0.92 (0.90-0.94)</td>
</tr>
<tr>
<td>CME Autopsy Report</td>
<td>0.90 (0.87-0.93)</td>
<td>0.86 (0.83-0.90)</td>
</tr>
<tr>
<td>Hospital Record*</td>
<td>0.94 (0.92-0.95)</td>
<td>0.91 (0.89-0.93)</td>
</tr>
</tbody>
</table>

Among a random sample of 28 decedents and an oversample of 28 hospitalized decedents enriched 3:1 for cardiovascular disease. CME = Coroner / Medical Examiner. Kappa = prevalence- and bias-adjusted kappa coefficient. *Mean, biomarker-specific intra-class correlation coefficient (95% confidence interval) = 0.96 (0.95-0.98).

Circulation 2022:145(S11);P154.
Wave V Vital Events – Results

• Investigation & Abstraction
  • Manner & Underlying Cause of Death

<table>
<thead>
<tr>
<th>Manner of Death</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accidental</td>
<td>41.6</td>
</tr>
<tr>
<td>Natural</td>
<td>33.4</td>
</tr>
<tr>
<td>Suicide</td>
<td>13.2</td>
</tr>
<tr>
<td>Homicide</td>
<td>10.1</td>
</tr>
<tr>
<td>Undetermined</td>
<td>1.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Underlying Cause of Death</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Vehicle Accident</td>
<td>16.1</td>
</tr>
<tr>
<td>Cardiovascular Disease</td>
<td>15.1</td>
</tr>
<tr>
<td>Accidental Drug Intoxication</td>
<td>13.9</td>
</tr>
<tr>
<td>Suicide</td>
<td>11.1</td>
</tr>
<tr>
<td>Cancer</td>
<td>9.4</td>
</tr>
<tr>
<td>Homicide</td>
<td>7.2</td>
</tr>
<tr>
<td>Other Natural Cause</td>
<td>7.0</td>
</tr>
<tr>
<td>Infectious Disease</td>
<td>3.7</td>
</tr>
<tr>
<td>Other Accident</td>
<td>3.3</td>
</tr>
<tr>
<td>Unknown/Undetermined</td>
<td>3.3</td>
</tr>
<tr>
<td>Respiratory Disease</td>
<td>2.5</td>
</tr>
<tr>
<td>Digestive Disease</td>
<td>2.3</td>
</tr>
<tr>
<td>COVID-19</td>
<td>2.2</td>
</tr>
</tbody>
</table>

*From death certificate
†From ICD Codes (NDI)
Wave V Vital Events – Results

• Review, Classification & Adjudication

In Progress!
Wave V Biological Data & Vital Events

• Summary
  • Wave V biological data, weights, documentation & biospecimens available
    • sample size ~ 5,400
    • quality high
    • other inflammatory/immune, hepatic & neurodegeneration biomarkers pending
  • Vital events available
    • decedents (1994-2021) = 641
    • cumulative mortality = 3.1%
    • natural causes account for ~ 1/3
    • quality high
    • physician review, classification & adjudication ongoing
  • Stay tuned re dissemination! (https://addhealth.cpc.unc.edu/documentation/user-guides)
  • Consider ancillary studies! (https://addhealth-ancillary.cpc.unc.edu/home)
Acknowledgements

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Add Health was originally designed by J. Richard Udry, Peter S. Bearman, and Kathleen Mullan Harris at the University of North Carolina at Chapel Hill. Add Health is currently directed by Robert A. Hummer; it was previously directed by Kathleen Mullan Harris (2004-2021) and J. Richard Udry (1994-2004).

Information on obtaining Add Health data is available on the project website (https://addhealth.cpc.unc.edu).