2026 Add Health Wave VI Documentation

Add Health
The National Longitudinal Study of Adolescent to Adult Health

Cardiovascular Measures Appendix I: Baroreflex Sensitivity & Hemodynamic Recovery

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This document summarizes the rationale for and estimation of baroreflex sensitivity and hemodynamic recovery from the cardiovascular measures collected at the Wave VI home exam. Whenever possible, data collection and methods in Wave VI mirrored those of Wave V to ensure comparability of data between waves. This document is one in a set of Wave VI user guides. User guides are also available to describe protocols for the following biological measures in Wave VI:

- Anthropometrics
- Biomarker Weights
- Cardiovascular Measures
- Glucose Homeostasis
- Hepatic Injury
- Home Exam – Medication use
- Home Exam Questionnaire and QC Metrics
- Infection
- Inflammation and Immune Function
- Lipids
- Neurodegeneration
- Renal Function

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1. Introduction

This is an appendix to *Add Health Wave VI Documentation: Cardiovascular Measures*[1]. Please refer to that user guide for complete descriptions of the cardiovascular data collection procedures and measures disseminated by the study at that time. In addition to the measures described there, this appendix introduces three more constructed measures that are included in the Add Health Wave VI data:

- Baroreflex sensitivity
- Pulse rate recovery
- Systolic blood pressure recovery

The rationale for their estimation and description of their quality control are provided below.

2. Rationale

The carotid sinus, aortic arch, heart, and lungs contain stretch receptors that are sensitive to increases in arterial, cardiac filling, and central venous blood pressure. These sinoaortic and cardiopulmonary baroreceptors project information about decreases in blood pressure to the spinal cord and brain which in turn, increase sympathetic and decrease parasympathetic stimulation of the heart and peripheral blood vessels. This baroreceptor reflex arc mediates the increase in pulse rate that usually accompanies decreases in systolic blood pressure over serial recordings, an autonomic phenomenon attributed to recovery from stress associated with instrumentation for sphygmomanometry and initial cuff inflation. Because baroreceptor reflexes prevent short-term fluctuation of blood pressure and their impairment is associated with cardiovascular diseases such as hypertension, diabetes, coronary heart disease, and heart failure[2,3], we estimated baroreflex sensitivity (BRS), pulse rate recovery (PRR) and systolic blood pressure recovery (SBPR) at Add Health Wave VI.

3. Estimation

Estimation was restricted to 6,004 participants with non-missing sampling weights and all three resting, seated measures of SBP (mmHg) and PR (beats/min). It involved converting PR to its unit-corrected reciprocal, RR interval duration (RR, ms) = 60,000 ÷ PR, and then running random-effects models implemented in Stata® MP 19.5 using MIXED and the mean normalized Wave VI Biomarker Weights[4] to estimate BRS as the slope of the RR-SBP association, PRR as the increase in PR, and SBPR as the decrease in SBP across recordings.

3.1 Baroreflex Sensitivity (BRS)

The model used to estimate BRS (ms/mmHg) was given by: $RR_{ij} = \beta_0 + \beta_1 SBP_{ij} + \mu_{0j} + \mu_{1j} SBP_{ij} + e_{ij}$, where is the RR at the i^{th} measurement (i = 1, 2, 3) on the j^{th} participant (j =1, 2, 3 …, 5,141), β_0 and $\mu_{0j}$are the fixed and random intercepts, $\beta_1$and μ_{1j} are the fixed and random slopes, and $BRS_{.j} = \beta_1 + \mu_{1j}$.

3.2 Hemodynamic Recovery

3.2.1 Pulse Rate Recovery (PRR)

The model used to estimate PRR (beats/min) was given by: $PR_{ij} = \beta_0 + \beta_1 time_{ij} + \mu_{0j} + \mu_{1j} time_{ij} + e_{ij}$, where is the PR at the i^{th} measurement (i = 1, 2, 3) on the j^{th} participant (j = 1, 2, 3 …, 5,141), β_0 and $\mu_{0j}$are the fixed and random intercepts, $\beta_1$and μ_{1j} are the fixed and random slopes at times (0,1,2), and $PRR_{.j} = \beta_1 + \mu_{1j}$.

3.2.2 Systolic Blood Pressure Recovery (SBPR)

The model used to estimate SBPR (mmHg) was given by: $SBP_{ij} = \beta_0 + \beta_1 time_{ij} + \mu_{0j} + \mu_{1j} time_{ij} + e_{ij}$, where is the SBP at the i^{th} measurement (i = 1, 2, 3) on the j^{th} participant (j = 1, 2, 3 …, 5,141), β_0 and $\mu_{0j}$are the fixed and random intercepts, $\beta_1$and μ_{1j} are the fixed and random slopes at times (0,1,2), and $SBPR_{.j} = \beta_1 + \mu_{1j}$.

3.3 Example Computation

Figure 1 provides an example computation of $SBPR_{.j}$ as the sum of the overall fixed slope and participant-specific, random slope (extracted using MIXED post-estimation commands). $PRR_{.j}$and $BRS_{.j}$ were computed in an analogous way.

AID	Fixed Slope	Random Slope	SBPR
1	-0.834468648	0.6233026538	-0.211165995
2	-0.834468648	-1.991232002	-2.82570065
3	-0.834468648	0.3368083749	-0.497660273
4	-0.834468648	-1.575851221	-2.410319869
5	-0.834468648	1.1146554396	0.2801867912

Figure 1. Example of estimating SBPR (mmHg)

4. Quality Control

4.1 Reliability

We assessed the short-term reliability of BRS, PRR and SBPR among a race/ethnicity and sex-stratified random sample of 142 participants examined twice, 1-2 weeks apart among whom SBP and PR were measured following study protocol, typically by the same field interviewer and at approximately the same time of day. We used a nested, random-effects model to partition the variance of BRS, PRR and SBPR and estimated their reliability as the ratio of between-participant to total variance, i.e. a variance partitioning coefficient and 95% confidence interval.[5] Greater than 80% of the variance in each of the three measures was attributable to that found between participants. For BRS, the variance partitioning coefficient ranged from 0.91-0.93 over SBPs of 67-182 mmHg, and for PRR and SBPR, ranges were 0.93-0.93 and 0.83-0.86 over time.

4.2 Validity

See Cuthbertson, et al., 2014a and 2014b. [6,7]

5. The Baroreflex Sensitivity Data File (bbrs6.sas7bdat)

5.1 Structure

The structure of the disseminated baroreflex sensitivity data file is flat. This means that it is a participant-level data file, where each participant has one and only one record. The participant's identifying number (the AID variable) will appear in the data file only once.

5.2 Contents

The baroreflex data file includes the variables below, which are described in the corresponding codebook documentation that also contains descriptive statistics.

Variable Name	Variable Description
AID	Participant Identifier
H6BRS	Baroreflex sensitivity (ms/mmHg)
H6PRR	Pulse rate recovery (beats/min)
H6SBPR	Systolic blood pressure recovery (mmHg)

6. References

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