2014

Add Health Wave IV Documentation

Cardiovascular Measures Appendix I: Baroreflex Sensitivity & Hemodynamic Recovery

Report prepared by

Carmen C. Cuthbertson
Eric A. Whitsel
Chirayath M. Suchindran
Ping Chen
Mariah M. Cheng
Redford B. Williams
Joyce W. Tabor
Ley A. Killeya-Jones
Jon M. Hussey
Carolyn T. Halpern
Kathleen Mullan Harris

Carolina Population Center
University of North Carolina at Chapel Hill
206 W. Franklin Street
Chapel Hill, NC 27516-2524

Add Health

Table of Contents

1. Introduction

This is an appendix to *Add Health Wave IV Documentation: Cardiovascular and Anthropometric Measures* (Entzel et al., 2009). 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 IV public use 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 (La Rovere et al., 2008; Eckberg, 1992), we estimated baroreflex sensitivity (BRS), pulse rate recovery (PRR) and systolic blood pressure recovery (SBPR) at Add Health Wave IV.

3. Estimation

Estimation was restricted to 14,003 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) = $60,000 \div$ PR, and then running random-effects models implemented in Stata® 13 using XTMIXED and multi-level survey weights (Chen et al., 2014) 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: $\quad = \beta_0 + \beta_1 SBP_{ij} + \quad +$ $SBP_{ij} + \quad$, where $\quad$ is the RR at the ith measurement ($i = 1,\ldots,3$) on the jth participant ($j =$

1, …, 14,003), β and   are the fixed and random intercepts,   and   are the fixed and random slopes, and $= \beta_1 + u_{1j}$.

3.2 Hemodynamic Recovery

3.2.1 Pulse Rate Recovery (PRR)

The model used to estimate PRR (beats/min) was given by: $PR_{ij} = \beta_0 + \beta_1 time_{ij} + u_{0j} + u_{1j} time_{ij} + e_{0ij}$, where PR_{ij} is the PR at the ith measurement ($i = 1,…,3$) on the jth participant ($j = 1, …, 14{,}003$), β_0 and u_{0j} are the fixed and random intercepts, β_1 and u_{1j} are the fixed and random slopes at times (0,1,2), and $PRR_{.j} = \beta_1 + u_{1j}$.

3.2.2 Systolic Blood Pressure Recovery (SBPR)

The model used to estimate SBPR (mmHg) was given by: $SBP_{ij} = \beta_0 + \beta_1 time_{ij} + u_{0j} + u_{1j} time_{ij} + e_{0ij}$, where SBP_{ij} is the SBP at the ith measurement ($i = 1,…,3$) on the jth participant ($j = 1, …, 14{,}003$), β_0 and u_{0j} are the fixed and random intercepts, β_1 and u_{1j} are the fixed and random slopes at times (0,1,2), and $SBPR_{.j} = \beta_1 + u_{1j}$.

3.3 Example Computation

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

Table 1. Example of estimating SBPR (mmHg).

AID	Fixed Slope	Random Slope	SBPR
1	-1.12425	-3.58024	-4.70449
2	-1.12425	-0.6894	-1.81365
3	-1.12425	0.30256	-0.82169
4	-1.12425	1.802667	0.67842
5	-1.12425	-1.15347	-2.27771

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 100 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 (Cuthbertson, et al., 2014). We used a nested, random-

effects model to partition the variance in of BRS, PRR and SBPR and estimate their reliability as the ratio of between-participant to total variance, i.e. a variance partitioning coefficient and 95% confidence interval (Goldstein, 1995). Greater than 75% of the variance in each of the three measures was attributable to that between participants. For BRS, the variance partitioning coefficient ranged from 0.84-0.94 over SBPs of 90-180 mmHg, and for PRR and SBPR, ranges were 0.85-0.86 and 0.76-0.79 over time.

4.2 Validity

We dichotomized the measures at their means and then used logistic regression to estimate their associations with cardiovascular disease risk factors as odds ratios and 95% confidence intervals at Add Health Wave IV (Cuthbertson, et al., 2014). Relative to those without a given cardiovascular risk factor, the odds ratios for low BRS, PRR, and SBPR increased with increasing body mass index, blood pressure, and hemoglobin A1c.

5. References

Chen P, Chantala K. (2014). *Guidelines for analyzing Add Health data*. UNC Chapel Hill: Carolina Population Center. Available at http://www.cpc.unc.edu/projects/addhealth/data/guides/wt-guidelines.pdf.

Cuthbertson CC, Suchindran CM, Harris KM, Hussey JM, Halpern CT, Tabor JW, Williams RB, Killeya-Jones L, Whitsel EA. (2014). Hemodynamic recovery and baroreflex sensitivity are reliable and associated with cardiovascular disease risk factors in a nationally representative sample of young US adults. *Circulation*;129(S1):AP3244.

Eckberg DL, Sleight P. (1992). *Human baroreflexes in health and disease*. New York: Oxford University Press.

Entzel P, Whitsel EA, Richardson A, Tabor J, Hallquist S, Hussey J, Halpern CT, Harris KM. (2009). *Add Health Wave IV documentation: Cardiovascular and anthropometric measures*. UNC Chapel Hill: Carolina Population Center. Available at http://www.cpc.unc.edu/projects/addhealth/data/guides/Wave%20IV%20cardiovascular%20and%20anthropometric%20documentation%20110209.pdf.

Goldstein H. (1995). *Multilevel Statistical Models*. New York: Halsted Press.

La Rovere MT, Pinna GD, Raczak G. (2008). Baroreflex Sensitivity: Measurement and Clinical Implications. *Ann Noninvasive Electrocardiol*;13(2):191-207.