**Blood pressure**

This document describes steps for two traits and two analyses:

* **Systolic blood pressure (SBP)**
* **Diastolic blood pressure (DBP)**

**Overall procedure**

1. Extract trait measurements using measurement codes and calculations
2. Convert measurement units to expected units, if necessary
3. Apply measurement exclusion criteria, other than statistical outliers
4. Prepare measurements for analysis
5. Remove statistical outliers
6. Compute a single value per individual for inclusion in analysis
7. Calculate counts of flagged individuals

**Measurement codes and calculations**

The [primed\_consortia\_legacy\_project\_phenotypes GitHub repository](https://manning-lab.github.io/primed_consortia_legacy_project_phenotypes/) provides files containing codes for the following vocabularies. Files can be downloaded and used to identify measurements.

SBP

* + SBP\_codes.csv
  + SBP\_LOINC\_codes.csv

DBP

* + DBP\_codes.csv
  + DBP\_LOINC\_codes.csv

**Medications**

Use available mapping to find all drugs/medication in the hierarchical [Anatomical Therapeutic Chemical (ATC) Classification](https://www.who.int/tools/atc-ddd-toolkit/atc-classification).

**Blood Pressure Lowering Medications**

ATC 2nd level [C02: ANTIHYPERTENSIVES](https://athena.ohdsi.org/search-terms/terms/21600381)

See this page for codes: ​​[Blood Pressure Lowering Medications](https://manning-lab.github.io/primed_consortia_legacy_project_phenotypes/Blood-Pressure-Lowering-Medications.html)

Also attached as BP\_meds.csv

* Note: Could also include ICD code Z79.899, indicating “Other long-term (current) drug therapy” due to no direct access to patient EHRs. Biobanks with access to EHRs that enable identifying antihypertensive medications directly should not use this code.

**Expected units**

Please convert values measured in other units of measurement to the following units:

* SBP: mm Hg
* DBP: mm Hg

**Exclusion criteria**

Exclusions are the same for both SBP and DBP.

**Individual exclusion criteria**

Not applicable for this analysis.

**Measurement exclusion criteria**

The following measurements should be excluded from the analysis. Other measurements from an individual may still be included in analysis.

* Age at measurement <18 years
* Exclude measurements taken at Inpatient or Emergency Department visits. Alternatively, keep only measurements taken at Outpatient visits. Take whichever approach is most appropriate for your EHR.
* Exclude measurements for individuals with any of these conditions at the time of Blood Pressure measurement (Codes are in BP\_Exclusions\_and\_Flags file):
  + End stage kidney disease
  + Pregnancy (on date of measurement)

**Prepare measurements for analysis**

For both SBP and DBP, measurements taken at the same clinic visit should be combined using the following procedure:

* Calculate the average measurement from measurements taken at a single visit.
  + The average should be calculated using two measurements, if possible.
  + If more than two measurements were taken at the same visit, the average should be calculated using the second and third measurements.
  + In cases where either of the measurements is missing, the average should be calculated discarding the missing value.

**Remove statistical outliers**

* Remove measurements that are outside Q1 (first quartile) - 3\*IQR (interquartile range) and Q3 (third  quartile) + 3\*IQR (interquartile range) in the total population, after applying all other exclusions

**Compute a single value per individual for inclusion in analysis**

After all exclusions are applied, the remaining measurements can be used to compute the final value for each individual for analysis.

The same procedure should be followed for both SBP and DBP.

* Calculate the median value of the trait measurement (which have already been averaged by visit).
* Extract the age corresponding to the visit at which median blood pressure measurement was recorded.
* Extract the BMI corresponding to the visit at which the median blood pressure measurement was recorded. If BMI is missing at visit, use the BMI value from the closest available visit to the median BP visit
* If the participant has a record of BP lower medication use at any timepoint before the median BP measurement, adjust for  BP lowering medication use by adding 15 mmHg to SBP and 10mmHg to DBP.

**Flagged individuals**

Flagged individuals can still be included in analysis, but the number of participants with these conditions should be reported. These flag codes are present in the BP\_Exclusions\_and\_Flags file included on the algorithm page.

* Chronic kidney disease
* Atherosclerosis
* Cushing's Syndrome
* Conn’s Syndrome
* Hypothyroidism
* Thyrotoxicosis (Hyperthyroidism)
* Benign neoplasm of adrenal gland (Pheochromocytoma)
* Type 2 Diabetes