**Phenotype Algorithm for Body Mass Index (BMI) – eMERGE Phase-IV Program**

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The pseudocode for BMI is listed below. Questions regarding this algorithm can be directed to Steve Gilhool (gilhools@chop.edu).

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| **Pseudocode** |
| **Step**  | **Description**  |
| 0 | Clean BMI data using CHOP BMI cleaning software* Height is cleaned using Bayesian outlier rejection
* Weight is cleaned using Gaussian Process regression with sigma clipping
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| Identify cohort under evaluation and obtain gender, race, and date of birth  |

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| 2 | Exclude subjects with malignant cancer, identified by meeting the following criteria: 4 or more inpatient or outpatient diagnoses on different days with any ICD9 code between 140.\* and 209\* and any C\* ICD10 code |
| 3 | Exclude subjects who have ever taken growth hormone. Relevant medication generic names are listed in the *BMI\_Meds* spreadsheet |
| 4 | Exclude BMI values after bariatric surgery. Relevant procedure codes are listed in the *BMI\_Procedures* spreadsheet |
| 5 | Exclude subjects who have ever taken an appetitive suppressant. Relevant medication generic names are listed in the *BMI\_Meds* spreadsheet |
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| Exclude individual height/weight/BMI values: * Remove weight measures that occurred after bariatric surgery (Procedure codes are listed in the *BMI\_Procedures* spreadsheet)
* Remove weight measures >700 pounds
* Remove BMI values >100 kg/m2
* Remove values 6 months preceding and one year following any pregnancy code (ICD9 codes 630.\* through 679.\*, V24\*, V72.4\*; ICD10 codes O00 through O9A; female; ages 12-55)
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| 7 | Exclude subjects without any weight measures |
| 8 | Calculate BMI: * For each remaining weight measure, calculate BMI using
* BMI = weight [kg]/( height\* height)[m2]
	+ Identify the maximum valid BMI measure

Identify the most recent valid BMI measure |
| 9 | Exclude subjects that have <3 BMI measures remaining |
| 10 | For all individuals, flag/exclude on the following [NOTE: Medication generic names for each of the underlined categories are listed separately in the *BMI\_Meds* spreadsheets]: * Anti-psychotic medication use
* Flag if user defined as having at least 2 indications of use (i.e. medication order, medication fill, active medication list) that are separated by at least 180 days at any time during or prior to the most recent BMI value
* Flag if only 1 use, or 1+ uses not separated by 180 days
* Oral steroid medication use
* Flag if user indicated for 10+ consecutive days of use
* Flag if user defined as having at least 2 indications of use (i.e. medication order, medication fill, active medication list) that are separated by at least 180 days at any time during or prior to the most recent BMI
* Flag if only 1 use, or 1+ uses not separated by 180 days
* Stimulant use
* Flag if user defined as having at least 2 indications of use (i.e. medication order, medication fill, active medication list) that are separated by at least 180 days at any time during or prior to the most recent BMI value
* Flag if only 1 use, or 1+ uses not separated by 180 days
* Insulin use
* Flag if user defined as having at least 2 indications of use (i.e. medication order, medication fill, active medication list) that are separated by at least 180 days at any time during or prior to the most recent BMI value
* Flag if only 1 use, or 1+ uses not separated by 180 days
* Beta-blocker use
* Flag if user defined as having at least 2 indications of use (i.e. medication order, medication fill, active medication list) that are separated by at least 180 days at any time during or prior to the most recent BMI value
* Flag if only 1 use, or 1+ uses not separated by 180 days
* Thyroid medication use
* Flag if user defined as having at least 2 indications of use (i.e. medication order, medication fill, active medication list) that are separated by at least 180 days at any time during or prior to the most recent BMI value
* Flag if only 1 use, or 1+ uses not separated by 180 days
* SSRI use
* Flag if user defined as having at least 2 indications of use (i.e. medication order, medication fill, active medication list) that are separated by at least 180 days at any time during or prior to the most recent BMI value
* Flag if only 1 use, or 1+ uses not separated by 180 days
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| 11 | Capture all ICD values and age for BMI measures. ICD9 codes V85\*; ICD10 codes Z68\*. |

**Data Dictionary and Implementation**

Since the height and weight measurements and BMI calculations are collected separately from the covariates, only the first occurrence (age in days) of any listed condition (excluding pregnancy) or drug exposure needs to be reported. For pregnancy, all ages in days can be reported or the earliest one for each pregnancy, if multiple. The logic for excluding BMI measures will take place at the time of analysis.

ICD codes indicating BMI ranges are reported for use as an internal check.

Detailed implementation directions are provided in the ReadMe file.

**Flowchart (based on Geisinger Extreme Obesity Algorithm)**

eMERGE-IV BMI Algorithm adapted from Geisinger Extreme Obesity Algorithm (2013). BMI is being implemented as a quantitative trait. PheKB maintains a catalog of the Geisinger algorithm and documentation: <https://phekb.org/phenotype/extreme-obesity>. This algorithm is for analysis. Sites only contributing covariates can simply compile the designated data.

No

Yes

Yes

3+ BMI measures at least 30 days apart

Identify cohort under evaluation

Clean height data

Clean weight data

Calculate BMI.

Clean BMI data.

Malignant cancer OR growth hormone

1+ height measures

1+ weight measures

**Exclude**

Yes

No

No

Yes

**Include and flag the following:**

**- Antipsychotics**

**- Oral steroids**

**- Stimulants**

**- Insulin**

**- Beta-blockers**

**- Thyroid medications**

**- SSRIs**