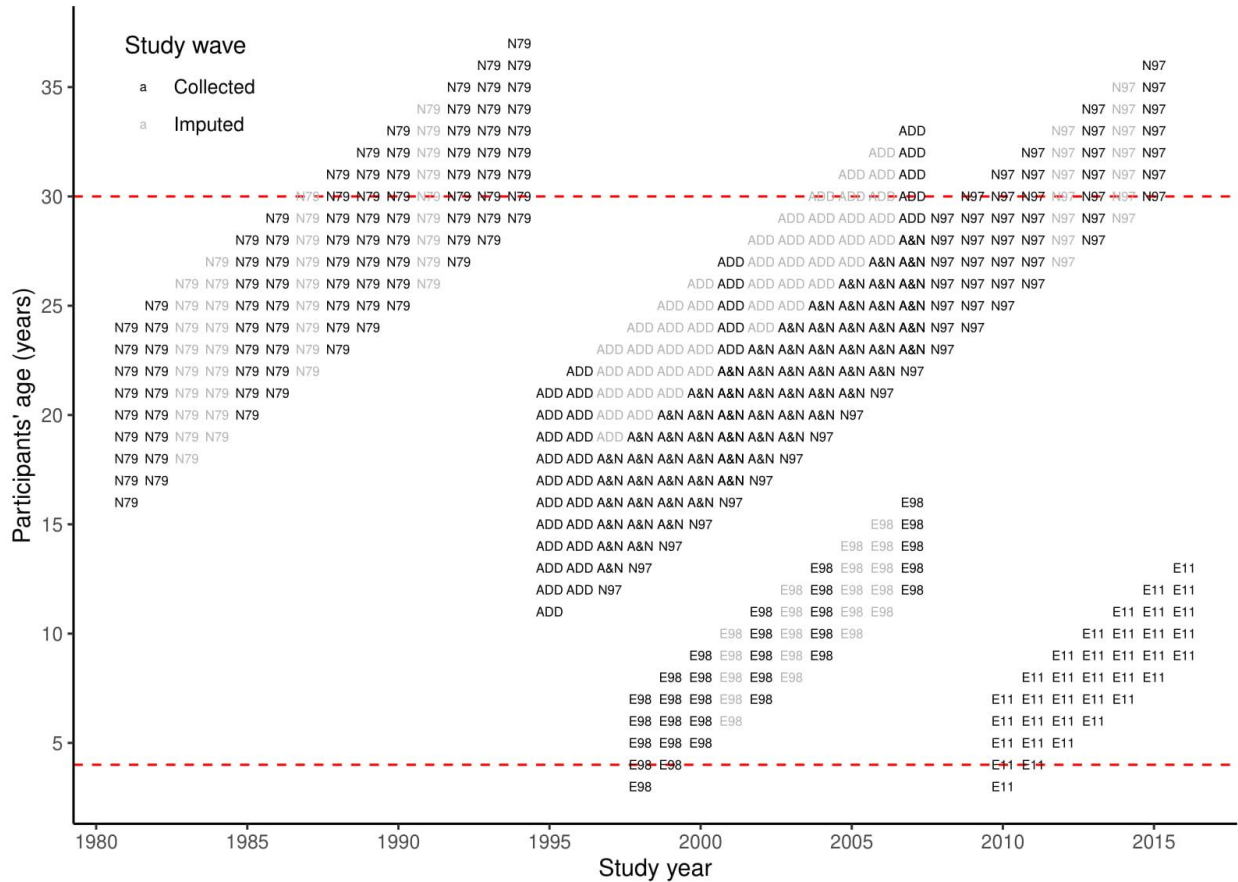**Appendix**
**Obesity Incidence in U.S Children and Young Adults: A Pooled Analysis**
**Rafei et al.**

# APPENDIX 1

**Appendix Figure 1.1.** Lexis diagram of the pooled data. Red horizontal dashed lines demarcate the age range investigated (4–30 years). Faded symbols show non-survey years, which have been imputed. ADD: ADDTH; N79: NLSY79; E98: ECLS-K:1998; E11: ECLS-K:2011; A&N: ADDTH and NLSY97 overlap.

**Appendix**
**Obesity Incidence in U.S Children and Young Adults: A Pooled Analysis**
**Rafei et al.**

## APPENDIX 2
### Correction for Measurement Error in Self-Reported Height/Weight

It is well-understood that self-reported anthropometric measures are subject to measurement error and social undesirability bias. For instance, people tend to underreport their weight systematically, and the magnitude of this underreporting is larger among obese people than normally weighted people and in females than males. Therefore, ignoring this source of error may result in biased estimates. One common approach to correct for measurement error is to use a validation dataset where both mismeasured and error-free variables are observed. This allows us to construct a measurement error model and estimate the magnitude of systematic bias. In this study, we utilized National Health and Nutrition Examination Survey (NHANES) as a validation dataset to adjust for the measurement error in NLSY and the baseline wave of ADDTH. Between 1999 and 2016, measures of weight and height have been both clinically measured and self-reported for a subsample of NHANES participants aged ≥16 years. While the earlier has been performed by trained staff via stadiometer and digital scale in the Mobile Examination Center, the latter has been collected by trained interviewers thought personal interviewing.[3,53] We restrict the sample to individuals aged <30 years (n=15,939).

Table 2.1 describes the sample size distribution and summery statistics in the NHANES 1999–2016 respondents aged 16–30 years by sex and race/ethnicity. As illustrated, for all racial/ethnic groups, people under-report their weight more than 1 kilogram on average. The magnitude of this bias is much larger in females than males. There is also evidence of slight overreporting of height across levels of race/ethnicity with slightly larger bias in males than females. To check whether these biases are statistically significant, we build a calibration model as below:

$$Y_{CM} = \beta_0 + \beta_1 Y_{SR} + \beta_2 SEX + \beta_4 RACE + \beta_5 SEX * Y_{SR} + \beta_6 RACE * Y_{SR} + \epsilon$$

Where $Y_{CM}$ and $Y_{SR}$ $denote$ the clinical and self-reported measures of weight (height), respectively, and $\epsilon$ is a normally distributed error term with zero mean. Note that $\beta_0$ and $\beta_1$ together represent the systematic bias. The interaction terms permit us to fit the model by levels of demographic information. The parameters estimate of the calibration model are shown in Table 2.2. We used this model to predict the error-free values of weight and height for the respondents in NLSY and ADDTH's baseline wave. Figure 2.1 depicts the scatter-plots of self-reported vs objectively measured weights and heights and associated regression lines in NHANES 1999–2016 data. Note that outliers (number of outliers in the calibration model for height: 38, 0.23%; for weight: 23, 0.14%) were identified and removed through Cook's distance before fitting the calibration model to NHANES data.

Note that correction for measurement error relies on the transportability assumption, meaning that the same calibration model holds in the datasets with mismeasured values of weight and height. Clearly, the NHANES data does not fully cover the age/year range of respondents NLSY or ADDTH. However, we checked the linear and quadratic effects of age and the trends over years in the calibration model and noticed that none of these effects are statistically significant (*p*-values in the calibration model of height: age:0.1712; age$^2$: 0.1907; year:0.1420; year$^2$:0.0302; p-values in the calibration model of weight: age:0.3784; age$^2$: 0.3279; year:0.3570; year$^2$:0.3312). This finding boosts the transportability assumption in that the measurement error model is not affected by age or survey year.

**Appendix**
**Obesity Incidence in U.S Children and Young Adults: A Pooled Analysis**
**Rafei et al.**

**Appendix Table 2.1.** Sample Characteristics of NHANES 1999–2016 Data Aged 16–30 Years

| Characteristic | Race/ethnicity | | | |
| --- | --- | --- | --- | --- |
| | White/other | Black | Hispanic | Total |
| **Total** | | | | |
| Sample size | 6,884 | 4,051 | 5,004 | 15,939 |
| Mean age (SD) | 22.204 (4.509) | 20.839 (4.293) | 21.201 (4.417) | 21.542 (4.465) |
| Mean clinically measured height (SD) | 1.700 (0.097) | 1.699 (0.097) | 1.652 (0.093) | 1.685 (0.098) |
| Mean self-reported height (SD) | 1.708 (0.103) | 1.706 (0.104) | 1.661 (0.097) | 1.693 (0.104) |
| Mean clinically measured weight (SD) | 74.807 (20.773) | 78.940 (23.455) | 73.295 (19.925) | 75.383 (21.342) |
| Mean self-reported weight (SD) | 73.520 (19.770) | 77.714 (21.014) | 72.189 (18.491) | 74.168 (19.823) |
| **Male** | | | | |
| Sample size | 3,319 | 2,027 | 2,361 | 7,707 |
| Mean age (SD) | 21.959 (4.481) | 20.552 (4.203) | 21.016 (4.405) | 21.300 (4.426) |
| Mean clinically measured height (SD) | 1.770 (0.074) | 1.767 (0.074) | 1.720 (0.071) | 1.754 (0.076) |
| Mean self-reported height (SD) | 1.782 (0.079) | 1.775 (0.084) | 1.726 (0.079) | 1.763 (0.084) |
| Mean clinically measured weight (SD) | 80.978 (20.728) | 82.047 (23.072) | 78.918 (20.062) | 80.628 (21.206) |
| Mean self-reported weight (SD) | 80.834 (19.305) | 82.062 (20.287) | 78.611 (18.238) | 80.476 (19.296) |
| **Female** | | | | |
| Sample size | 3,565 | 2,024 | 2,643 | 8,232 |
| Mean age (SD) | 22.432 (4.523) | 21.125 (4.363) | 21.367 (4.423) | 21.769 (4.490) |
| Mean clinically measured height (SD) | 1.635 (0.065) | 1.631 (0.065) | 1.592 (0.064) | 1.620 (0.068) |
| Mean self-reported height (SD) | 1.639 (0.070) | 1.638 (0.072) | 1.602 (0.069) | 1.627 (0.072) |
| Mean clinically measured weight (SD) | 69.062 (19.101) | 75.828 (23.428) | 68.271 (18.406) | 70.472 (20.276) |
| Mean self-reported weight (SD) | 66.711 (17.654) | 73.360 (20.832) | 66.451 (16.749) | 68.262 (18.443) |

*Note*: Reported numbers are unweighted representing the NHANES combined sample.

NHANES, National Health and Nutrition Examination Survey.

**Appendix**
**Obesity Incidence in U.S Children and Young Adults: A Pooled Analysis**
**Rafei et al.**

**Appendix Table 2.2.** Results of Measurement Error Model Based on NHANES 1999–2016 Data Aged 16–30 Years

| Covariate | Height (m) | | Weight (kg) | |
|---|---|---|---|---|
| | **Coef** | ***p*-value** | **Coef** | ***p*-value** |
| Intercept | 0.275 | <0.0001 | −2.893 | <0.0001 |
| SR H/W measure | 0.840 | <0.0001 | 1.038 | <0.0001 |
| Sex | | | | |
|    Male | 0 | – | 0 | – |
|    Female | −0.051 | <0.0001 | 2.373 | <0.0001 |
| Race/ethnicity | | | | |
|    White/other | 0 | – | 0 | – |
|    Black | 0.010 | 0.2545 | −1.298 | 0.0009 |
|    Hispanic | 0.021 | 0.0166 | −2.952 | <0.0001 |
| Sex*H/W | | | | |
|    Male*H/W | 0 | – | 0 | – |
|    Female*H/W | 0.019 | 0.0006 | 0.005 | 0.3018 |
| Race/ethnicity*H/W | | | | |
|    White/other*H/W | 0 | – | 0 | – |
|    Black*H/W | −0.010 | 0.0409 | 0.016 | 0.0024 |
|    Hispanic*H/W | −0.012 | 0.0185 | 0.035 | <0.0001 |

SR, self-reported; H/W, height/weight; NHANES, National Health and Nutrition Examination Survey; Coef, coefficient.

**Appendix**
**Obesity Incidence in U.S Children and Young Adults: A Pooled Analysis**
**Rafei et al.**

**Appendix Figure 2.1.** Scatter plots of objectively measured and self-reported height (a) and weight (b) and fitted regression line based on NHANES 1999–2016 data aged 16–30 years.



NHANES, National Health and Nutrition Examination Survey.

**Appendix**
**Obesity Incidence in U.S Children and Young Adults: A Pooled Analysis**
**Rafei et al.**
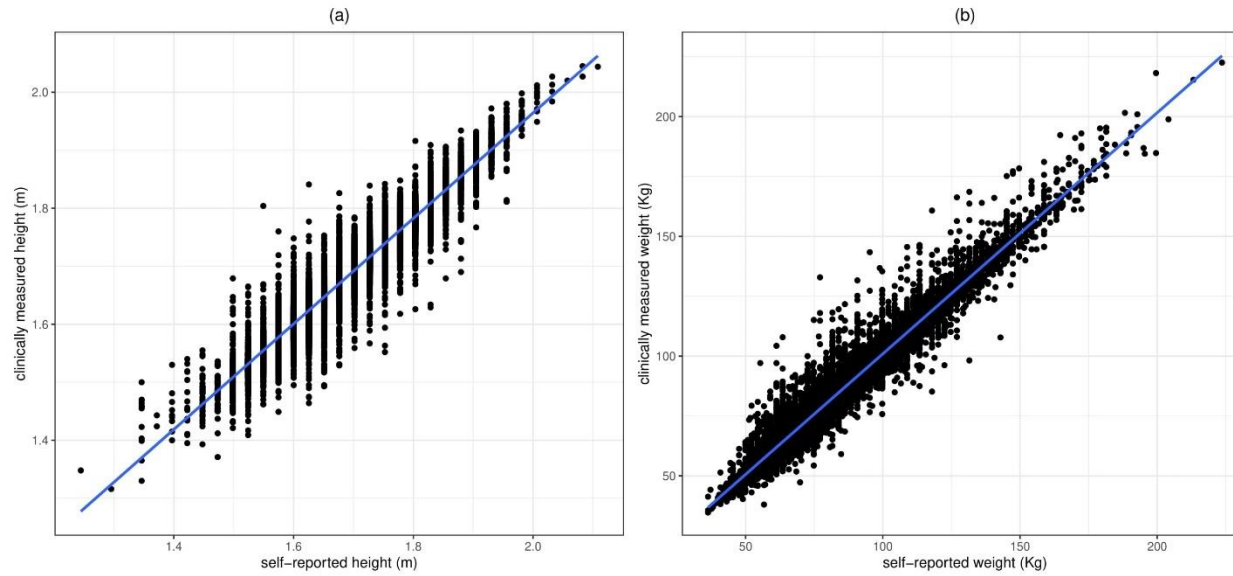
## APPENDIX 3

**Appendix Figure 3.1.** Age- and sex-specific thresholds for defining obesity.
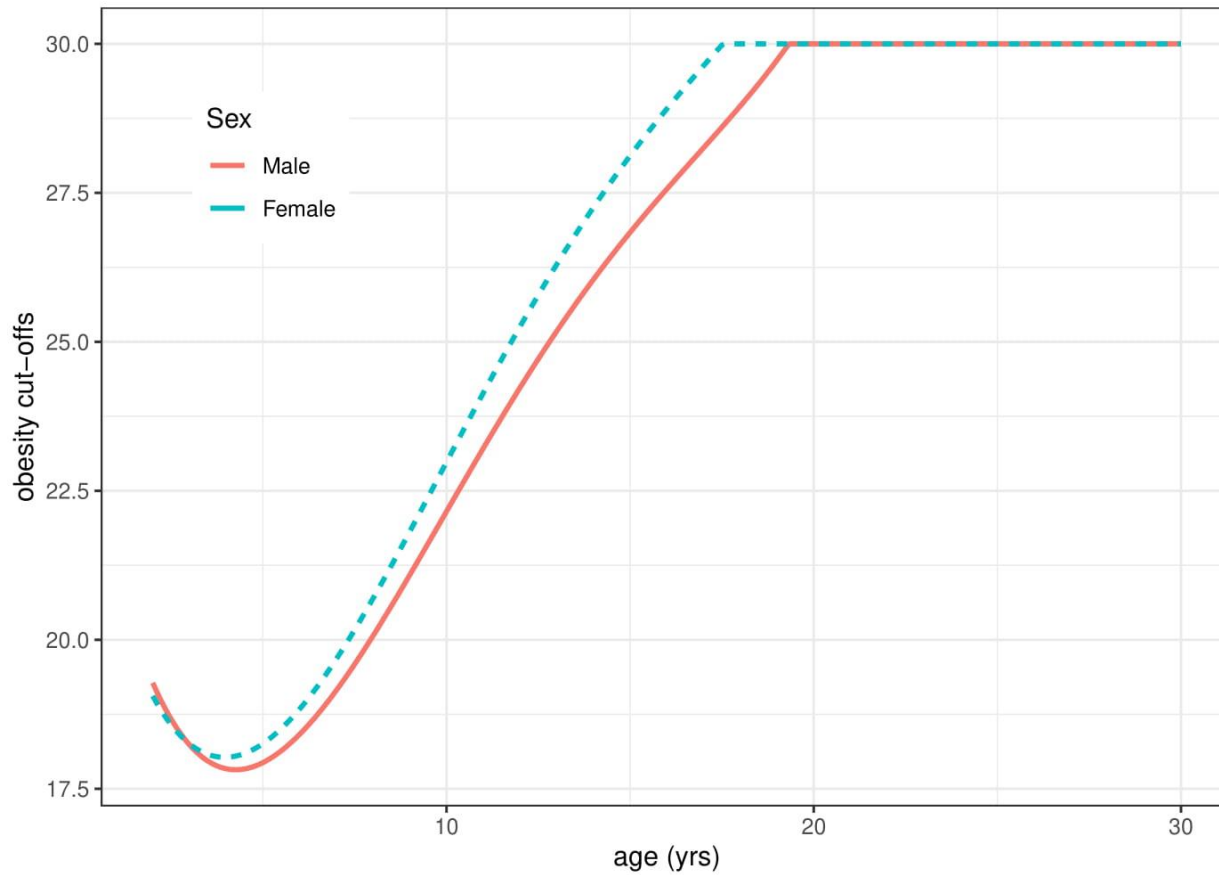


*Note*: Thresholds for those 4–17 years were based on the Center for Disease Control and Prevention's 95% percentile BMI growth chart. A BMI=30/kg/m$^2$ was used for those 17 years and older as indicated in the figure.