

The utility of standardized or crude weight measures in modeling of postnatal growth trajectories: Are there differences?

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Introduction

Analyses of growth trajectories are expanding in tandem with the growing interest in life course epidemiology. Z-scores are a frequent choice when modeling weight growth trajectories to standardize the sample to usually what is the CDC reference or WHO standard populations. When used for cross-sectional data, Z-scores have advantages including linear sex- and age-independent measures of weight outcomes. However, there is no appropriate rationale to use Z-scores, or an equivalent such as percentiles, when studying weight change in infancy.

Samples

Growth trajectory parameters for baseline exposure correspond to published estimates for three samples: Italy, Portugal and Chile. C. Pizzi et al. "Prenatal Influences on Size, Velocity and Tempo of Infant Growth: Findings from Three Contemporary Cohorts". In: *PLoS ONE* 9.2 (Feb. 27, 2014). Ed. by G. Wang, e90291. DOI: 10.1371/journal.pone.0090291

Aim

Use simulations to assess differences in power, type I error measures, and coefficient estimates of weight change differences across three different outcome measures in child anthropometric measures: weight, weight Z-score and weight percentiles.

Method

We simulated infant growth data using a Reed first order parametric model:

$$y = \beta_0 + \beta_1 \cdot t + \beta_2 \cdot \ln(t) + \frac{\beta_3}{t}$$

After simulating data, three models were fit with the simulated data:

Model 1

$$y_{ij} = \beta_0 + \beta_1 \cdot t + \beta_2 \cdot \text{group} + \beta_3 \cdot t \cdot \text{group} + e_{ij}$$

Model 2

$$y_{ij} = \beta_0 + \beta_1 \cdot t + \beta_2 \cdot \text{group} + \beta_3 \cdot t \cdot \text{group} + \beta_4 \cdot t^2 + e_{ij}$$

Model 3

$$y_{ij} = \beta_0 + \beta_1 \cdot \text{month.6} + \beta_2 \cdot \text{group} + \beta_3 \cdot \text{month.6} \cdot \text{group} + e_{ij}$$

Model Terms

y_{ij} the outcome: weight, Z-score or percentile

group a binary exposure factor

month.6 a binary variable for time with 1=month 6 and 0=month 0

e_{ij} error term with a autocorrelation structure, $\rho=0.5$ and $\sigma=0.75$

Results

Figure 1: Simulated weight growth curves with corresponding Z-score and percentile outcomes using Chilean growth parameters

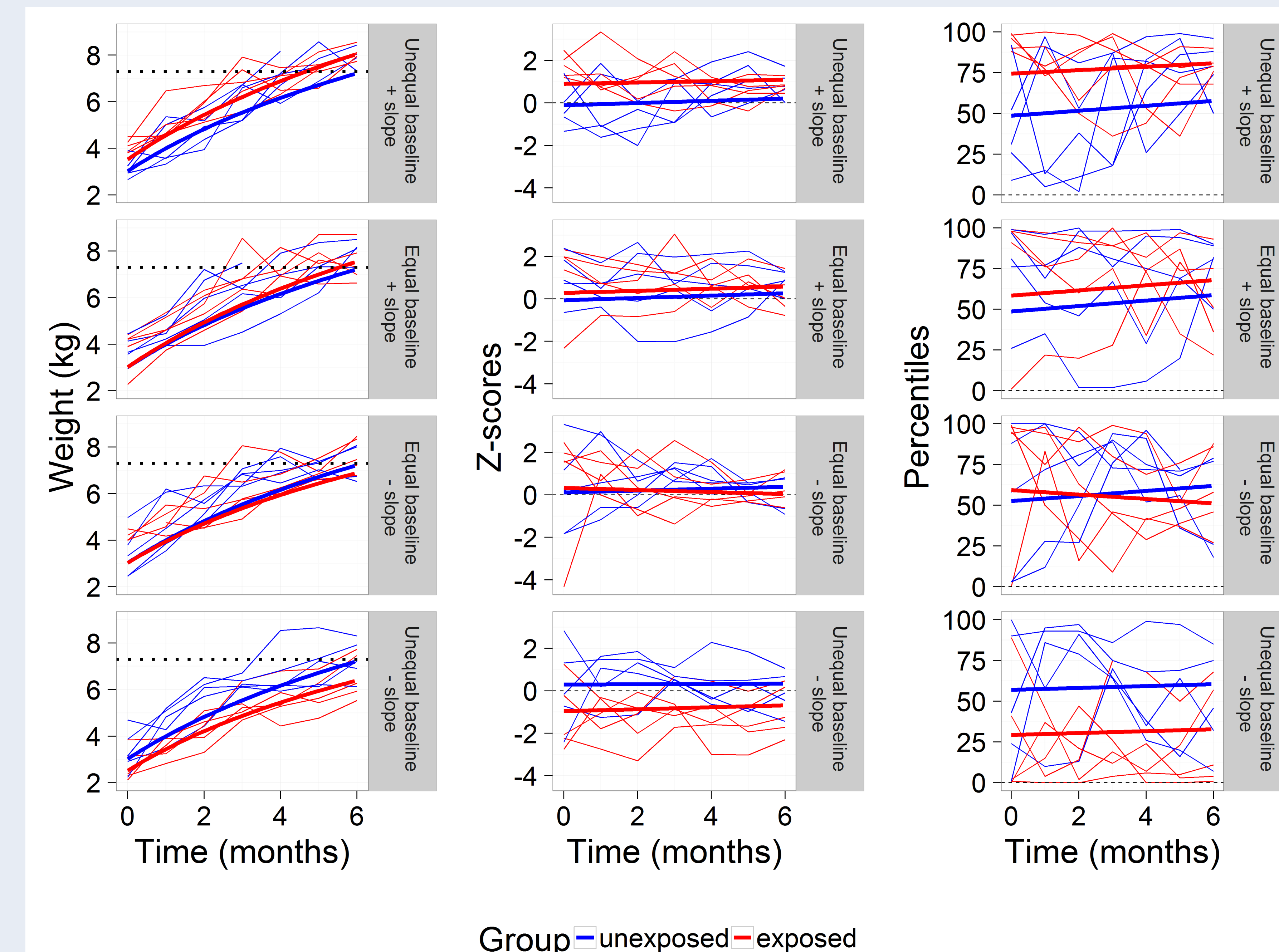
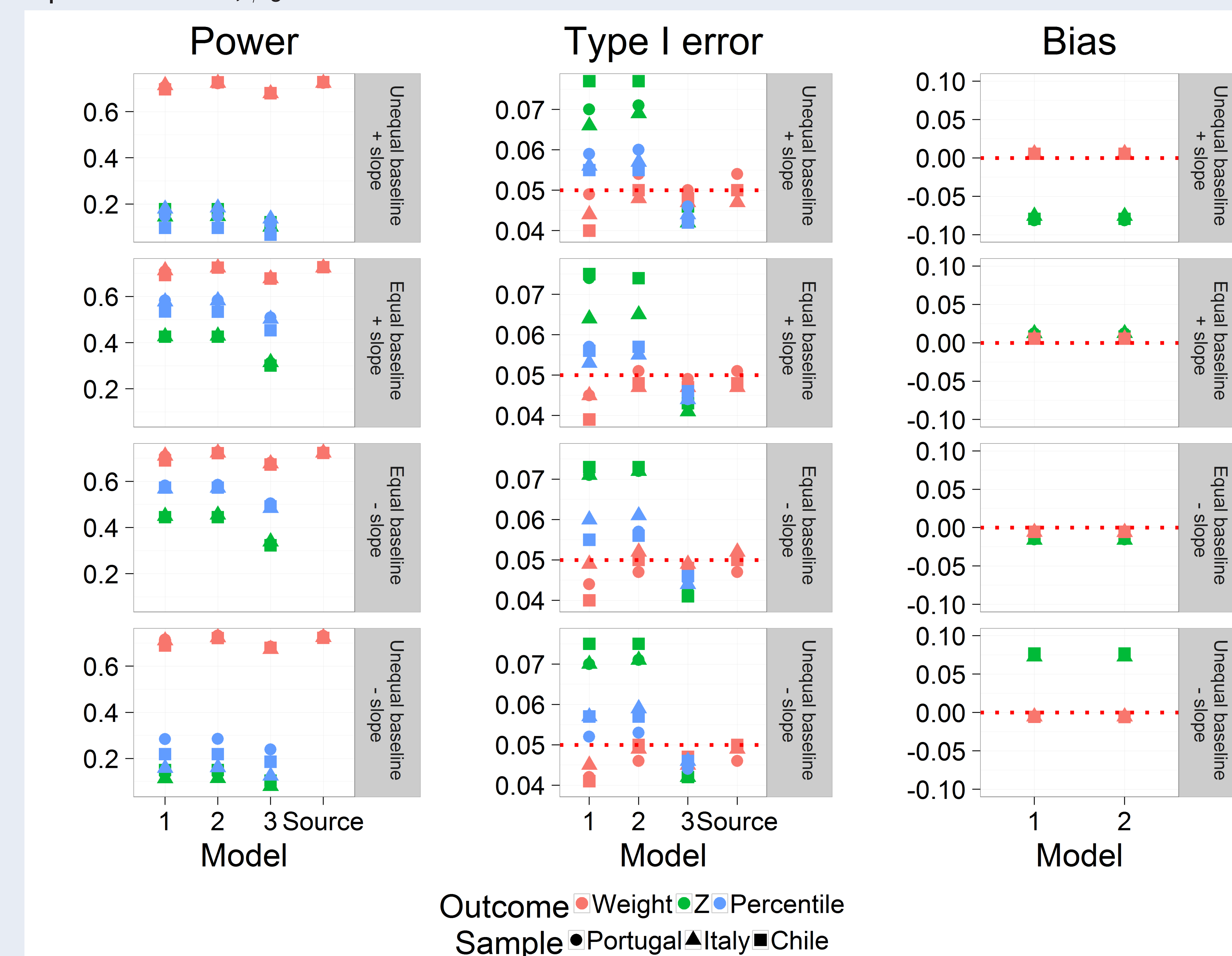


Figure 2: Comparison of power, type-I error and bias for product term for time and exposure effect, β_3 .



Results, cont . . .

Power Consistently greater with crude weight.

- Weight difference at baseline results in larger differential.

Type I error Crude weight measure closest to nominal Type I error of 0.05.

- Z-scores have greatest type I error for models 1 and 2.

Bias Baseline weight differences lead to opposite direction of effect for Z-score vs crude weight outcomes.

- No weight differences at baseline leads to similar estimates between Z-score and original weight outcomes.

Summary

Researchers often use a standardized measure of weight, such as Z-scores or percentiles, when examining longitudinal within-subject weight change as an exposure. An example of this approach is infant growth as a hypothesized exposure associated with cardiovascular outcomes in later life. Longitudinal analyses with weight Z-scores meant for cross-sectional use can lead to estimates conflicting with group differences in weight change. Other disadvantages relate to power and type I error.

Disadvantages of standardization

- Use of Z-scores meant for cross-sectional weight outcome measures can lead to opposite effects from crude weight outcomes leading to conflicting inference when comparing trajectories across groups.
- Simulations show evidence of lower power and greater type I error when using Z-scores.

Alternatives?

- Use crude weight and adjust for gender .

