

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

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## Introduction

- Growth trajectory characteristics are frequently used in life course analyses as an exposure through which later life adverse outcomes, such as cardiovascular disease, are linked.
- Z-scores are a frequent outcome choice when modeling weight growth trajectories. **Advantages** include sex- and age-independent dimensionless measures. **Disadvantage** is measure designed for cross-sectional use.
- Advantages of a standardized measure, such as Z-scores, are unclear in postnatal longitudinal analyses when compared to crude measure of weight.

## Aim

- Estimate group differences in postnatal weight change across three different outcomes and three models to assess precision, type I error and parameter estimate values via Monte Carlo simulations.

## Samples

- Growth trajectory parameters for baseline exposure correspond to published estimates for three samples: Italy, Portugal and Chile [1].

## Method

- We generated fixed effects infant growth data with a Reed first order parametric model  
(**Source**):  $y_{ij} = \beta_0 + \beta_1 \cdot t_{ij} + \beta_2 \cdot \ln(t_{ij}) + \frac{\beta_3}{t_{ij}} + \beta_4 \cdot \text{group}_i + \beta_5 \cdot t_{ij} \cdot \text{group}_i + e_{ij}$

- After simulating weight values, we converted simulated weight to Z-score and percentiles and fit three models:

- Model 1:**  
 $E(m_{ij}) = \beta_0 + \beta_1 \cdot t + \beta_2 \cdot \text{group} + \beta_3 \cdot t \cdot \text{group}$
- Model 2**  
 $E(m_{ij}) = \beta_0 + \beta_1 \cdot t + \beta_2 \cdot \text{group} + \beta_3 \cdot t \cdot \text{group} + \beta_4 \cdot t^2$
- Model 3**  $E(m_{ij}) =$   
 $\beta_0 + \beta_1 \cdot \text{month6} + \beta_2 \cdot \text{group} + \beta_3 \cdot \text{month6} \cdot \text{group}$

### Model Terms

- $y_{ij}$  weight for person  $i$  and time  $j$
- $t$  age (months)
- $m_{ij}$  weight, Z-score, percentile for person  $i$  and time  $j$
- group** a binary exposure factor
- month6** a binary variable for time with 1=month 6 and 0=month 0
- $e_{ij}$  error term with covariance following an 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

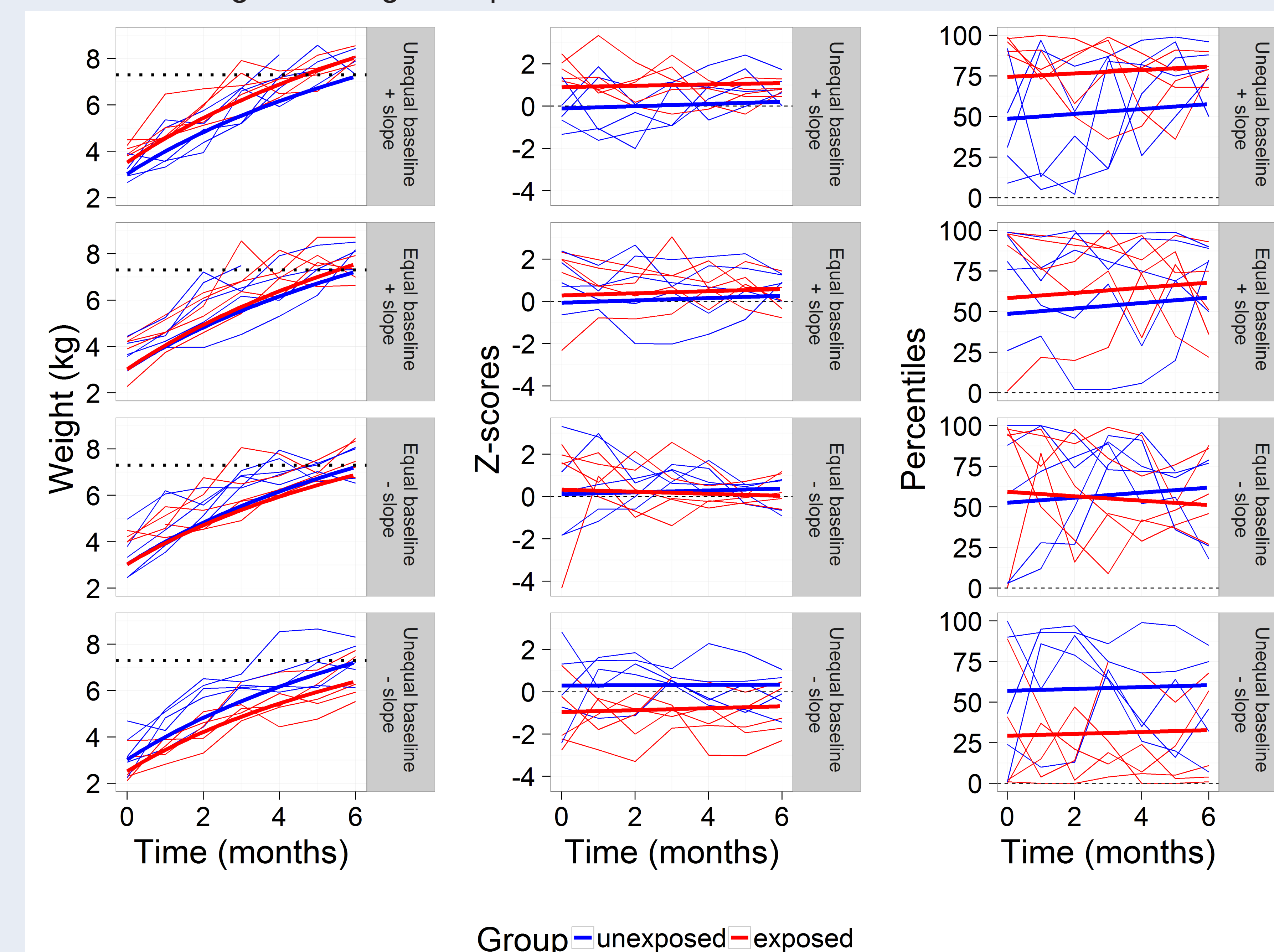
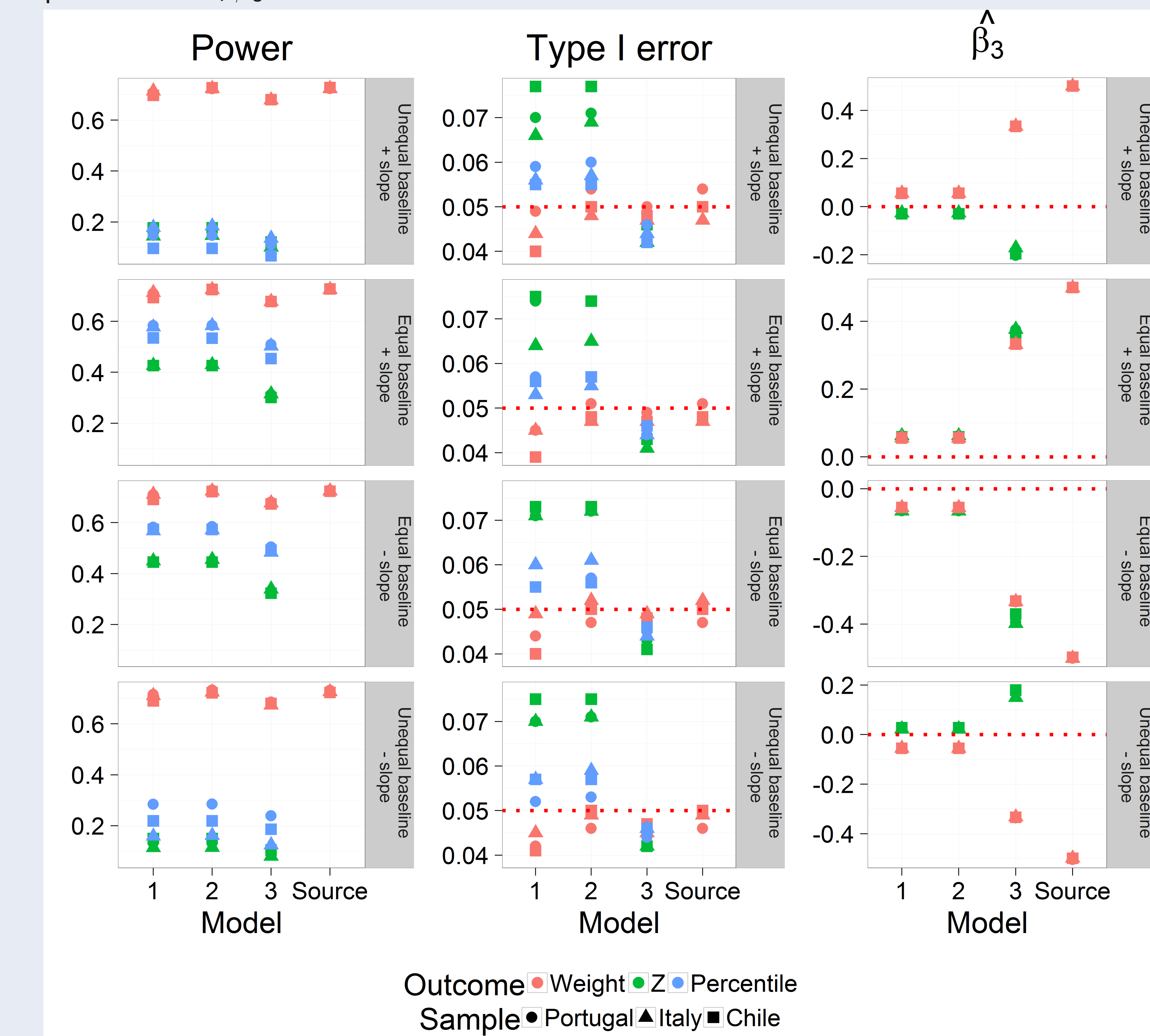


Figure 2: Comparison of power, type-I error and estimate for product term of time and exposure effect,  $\beta_3$ .



## Results, cont . . .

- Power** Consistently greater with crude weight.
- Type I error** Crude weight measure closest to nominal type I error of 0.05.
- Parameter estimates** Baseline weight differences lead to opposite direction of effect for Z-score vs crude weight outcomes.

## Conclusions

- Each measure examined in this project, Z-scores, percentiles and crude weight measures, serves a purpose as needed in research. However, these outcomes in growth trajectory analyses are not equivalent, and if used incorrectly can have adverse effects.
- Even at similar age and gender values, reference to a standard, WHO Z-scores, is not equivalent to crude weight values when assessing group differences in weight change over time.
- Supporting this conclusion, estimated group differences in weight change for all three outcomes only coincide in direction under certain conditions – equivalent weight at baseline.
  - ⇒ Special attention needed when interpreting standardized measures in longitudinal models. What is your target population?
- If comparisons to a standard such as WHO are not an objective, using Z-scores instead of crude weight can lead to
  - ⇒ biased estimates and conflicting inference.
  - ⇒ lower power and inflated type I error.
- Findings replicate lower power found in adolescent age group [2].
- Future efforts:** How does this finding extend to other contexts beside group comparisons in infant growth?

## References

- (1) 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). DOI: 10.1371/journal.pone.0090291
- (2) C. S Berkey and G. A Colditz. "Adiposity in adolescents: Change in actual BMI works better than change in BMI z score for longitudinal studies". In: *Annals of Epidemiology* 17.1 (Jan. 2007), pp. 44–50. DOI: 10.1016/j.annepidem.2006.07.014

