

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 linear sex- and age-independent measures of weight outcomes. **Disadvantage** is measure meant 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 and 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**): $y_{ij} = \beta_0 + \beta_1 \cdot t + \beta_2 \cdot \ln(t_{ij}) + \frac{\beta_3}{t_{ij}} + \beta_4 \cdot \text{group}_i + \beta_5 \cdot t \cdot \text{group}_i + e_{ij}$
- 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 , 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 variance 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

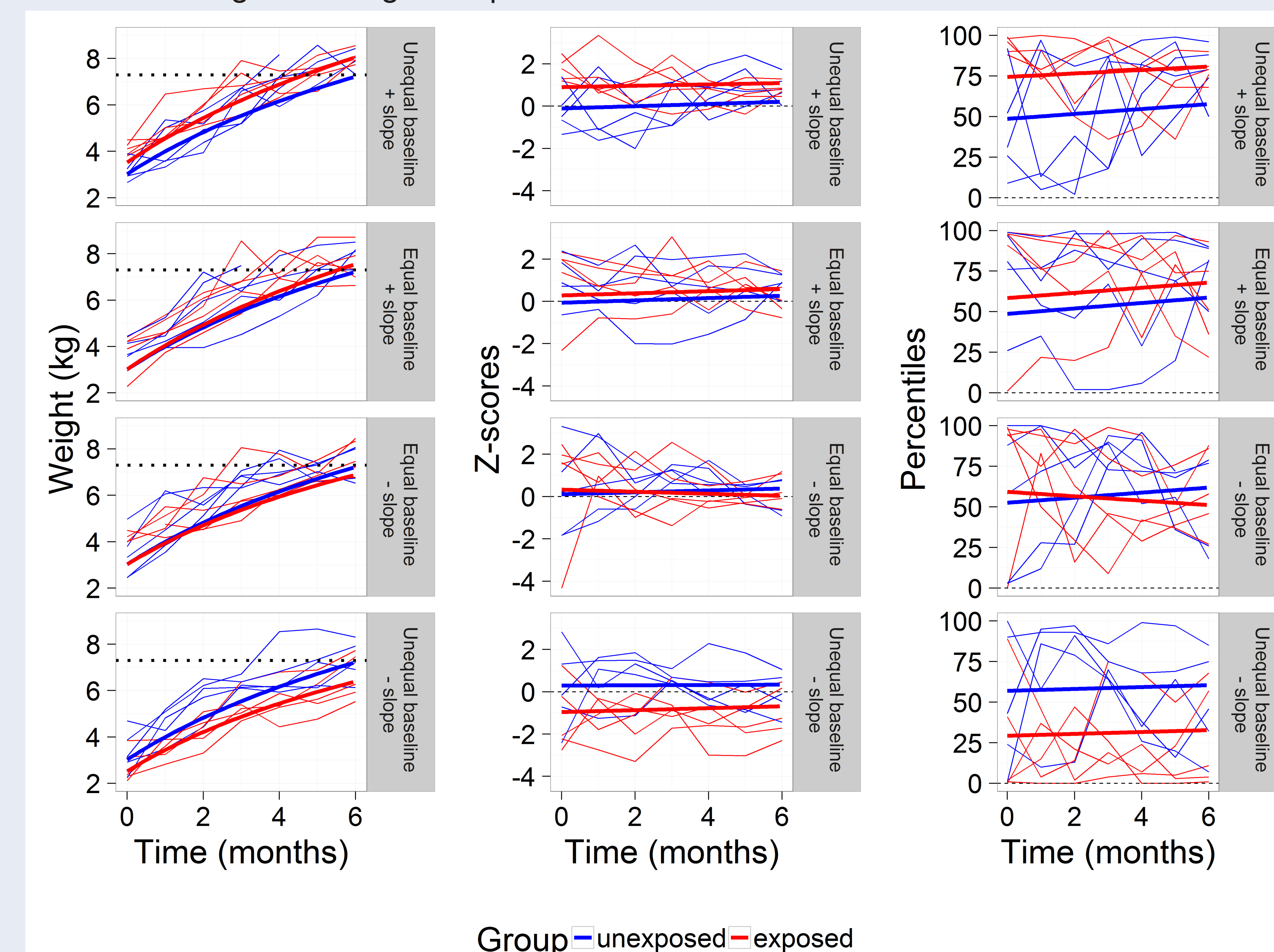
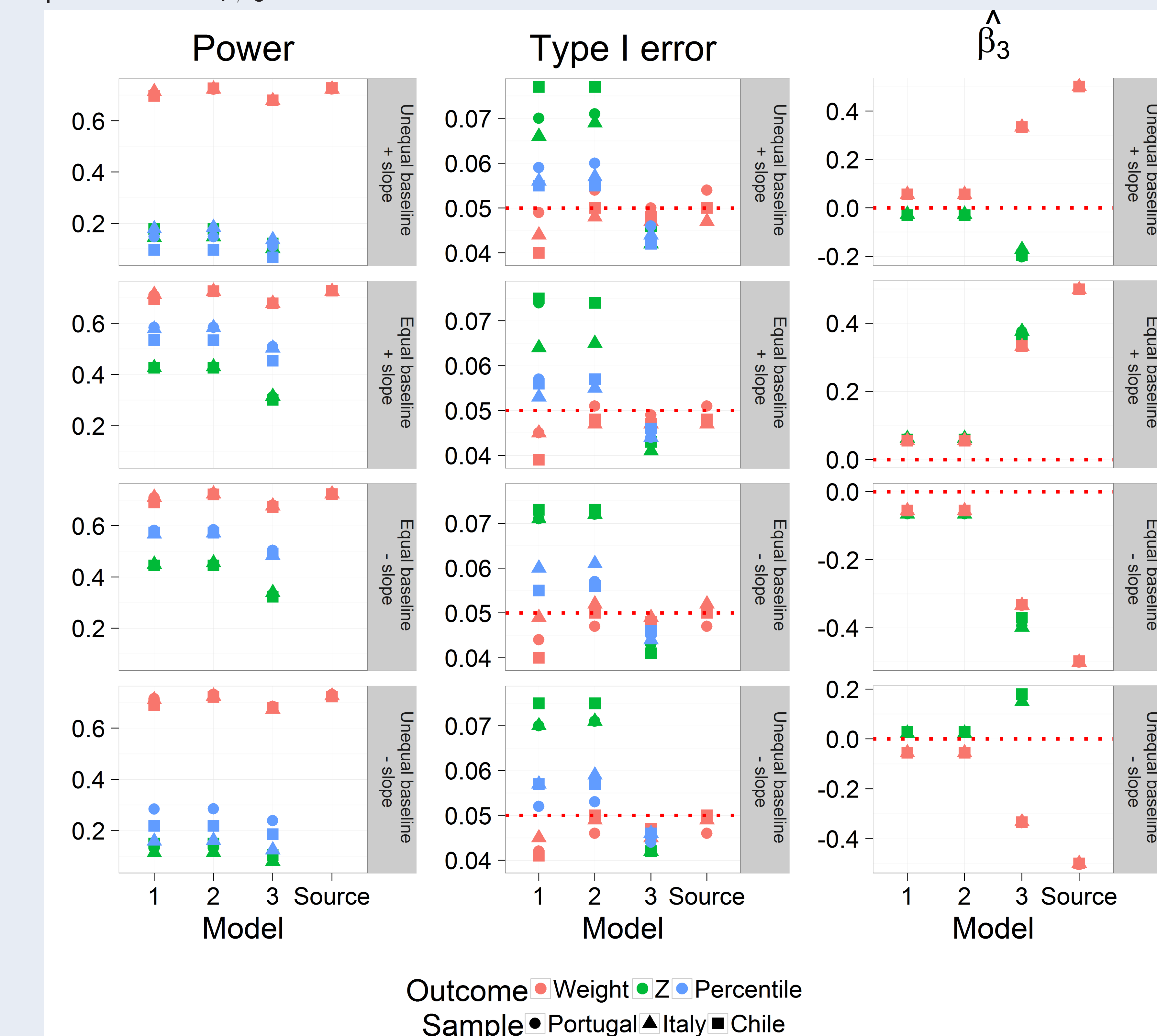


Figure 2: Comparison of power, type-I error and estimate for product term of time and exposure effect, β_3 .



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.**
- Parameter estimates** 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

- Z-scores or percentiles:** These measures provide a measure of weight relative to a referent population.
- Trajectory group differences using Z-scores or percentiles as outcomes can lead to estimates in opposite direction compared crude weight outcomes.
- Using these measures also leads to lower power to detect differences in slope and inflated type I error.

Conclusions

- Reference to a standard, such as Z-scores, is not equivalent to crude weight values when assessing group differences in change over time. Evidence from these simulations supports this conclusion, with parameter estimates only coinciding under certain conditions – equivalence at baseline.
- If comparisons to a referent such as WHO is not an objective,
 - \Rightarrow Z-scores can lead to biased estimates and conflicting inference.
 - \Rightarrow Z-score outcome associated with lower power and inflated type I error.
- This finding can extend to other contexts beside group comparisons in infant growth.
 - \Rightarrow Special attention needed when interpreting standardized measures in longitudinal models

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). Ed. by G. Wang, e90291. DOI: 10.1371/journal.pone.0090291

