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 has been no comparison of model performance for outcomes including Z-scores, or an equivalent such as percentiles, and crude weight when studying weight trajectories in infancy.

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.

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

Method

We generated fixed effects infant growth data with a Reed first order parametric model

(**Source**): $y_{ij} = \beta_0 + \beta_1 \cdot \mathtt{t} + \beta_2 \cdot \ln(\mathtt{t}_{ij}) + \dfrac{\beta_3}{\mathtt{t}_{ij}} + \beta_4 \cdot \mathtt{group}_i + \beta_5 \cdot \mathtt{t} \cdot \mathtt{group}_i + e_{ij}$

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

Model 1

$E(y) = \beta_0 + \beta_1 \cdot \mathtt{t} + \beta_2 \cdot \mathtt{group} + \beta_3 \cdot \mathtt{t} \cdot \mathtt{group}$

Model 2

$E(y) = \beta_0 + \beta_1 \cdot \mathtt{t} + \beta_2 \cdot \mathtt{group} + \beta_3 \cdot \mathtt{t} \cdot \mathtt{group} + \beta_4 \cdot \mathtt{t}^2$

Model 3

$E(y) = \beta_0 + \beta_1 \cdot \mathtt{month.6} + \beta_2 \cdot \mathtt{group} + \beta_3 \cdot \mathtt{month.6} \cdot \mathtt{group}$

Model Terms

y_{ij}	weight for person i and time j, age (months)
y	outcome: weight, Z-score, 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 variance following an autocorrelation structure, ρ=0.5 and σ=0.75

Results

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

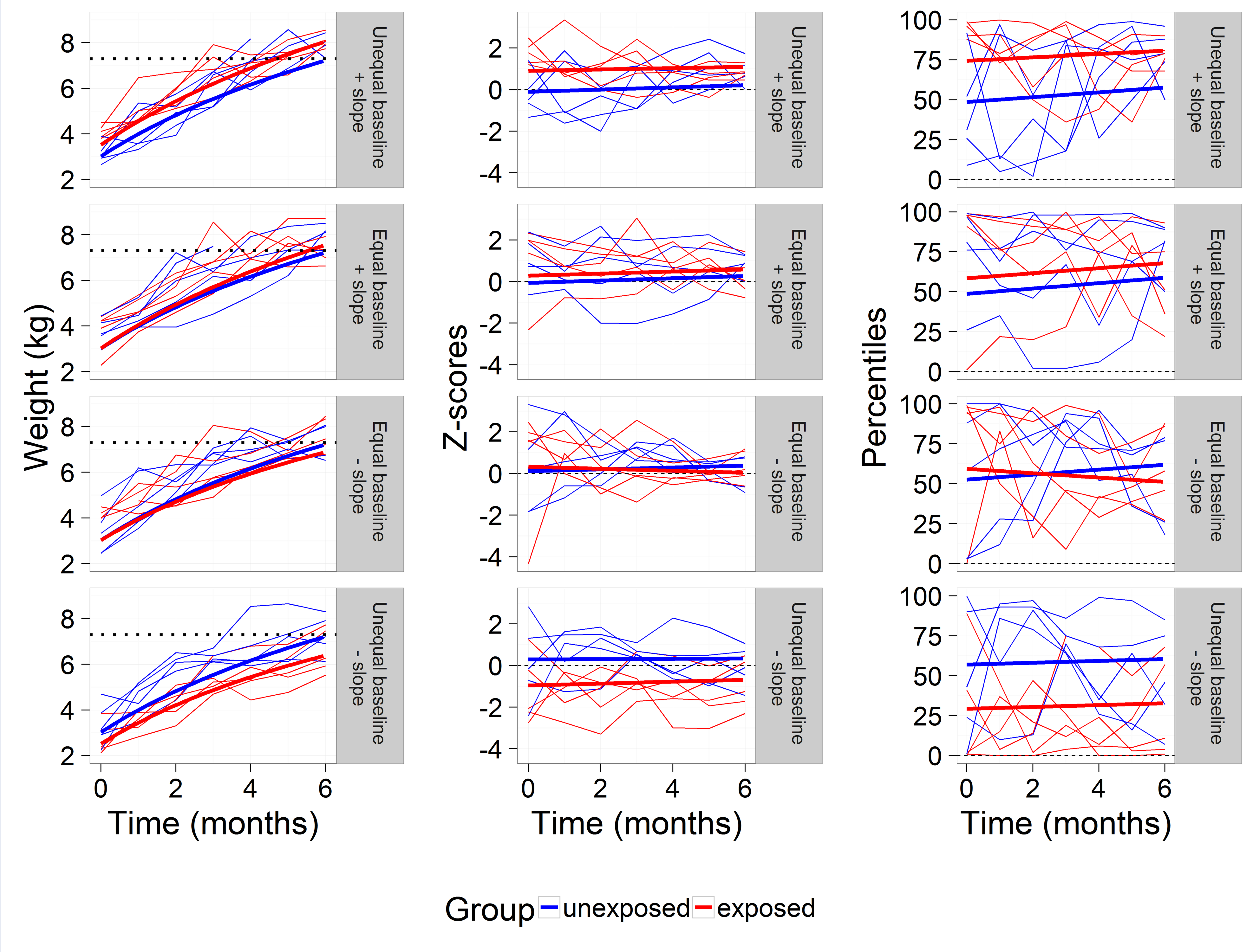
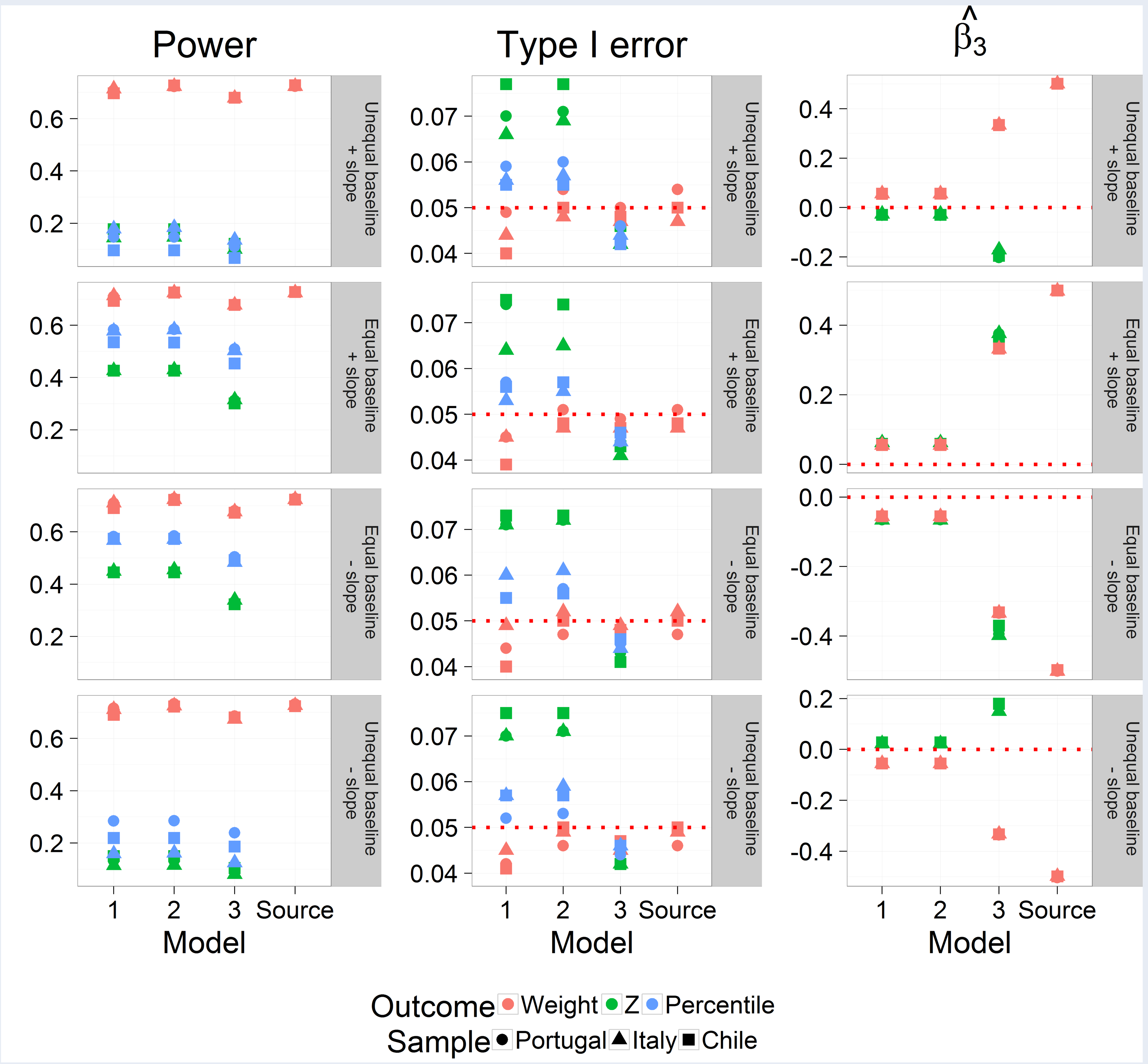


Figure 2: Comparison of power, type-I error and estimate for product term of time and exposure effect, β_3.



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.

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 lead to lower power to detect differences in slope and inflated type I error.

Conclusions

Each measure examined in this project: Z-scores, percentiles and crude weight measures, serves a purpose as needed in research.

- Transforming crude weight measures into Z-scores, as is commonly done in the literature, may provide benefits such as a reference point to a standard and comparability across genders, but it is important to note that this measure does not function the same as crude weight when examining growth trajectories.
- If reference to a standard is not an aim when examining group differences in growth trajectory patterns, crude weight measures as an outcome provide higher power and less inflated type I error.
- If growth trajectories serve as an exposure in life course analyses and comparison to a referent such as WHO is not an objective, Z-scores can lead to exposure misspecification and conflicting inference.

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