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

Ann Von Holle, Kari North, Ran Tao, UNC, Chapel Hill, NC; Sheila Gahagan, UCSD, San Diego, CA

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

$$y = \beta_0+\beta_1\cdot t+\beta_2\cdot\ln(t)+\frac{\beta_3}{t}+\beta_4\cdot\text{group}+\beta_5\cdot t\cdot\text{group}$$

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 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

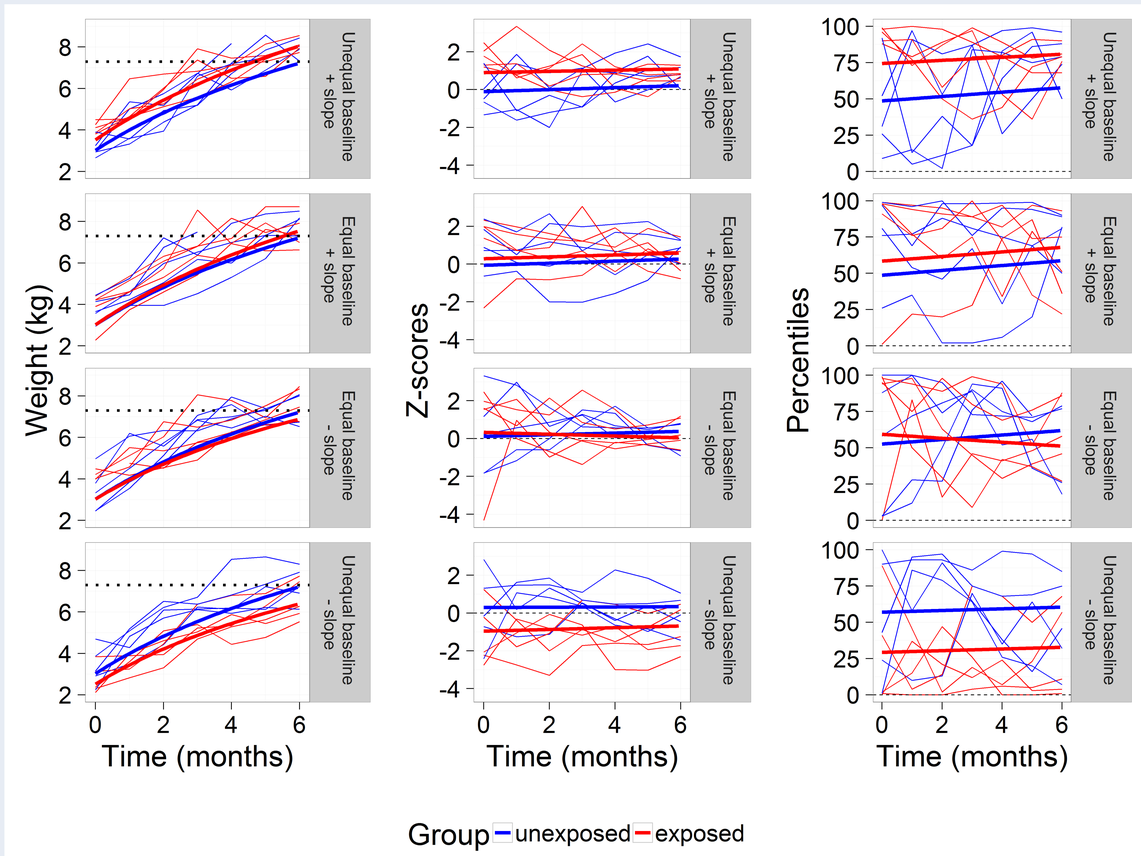
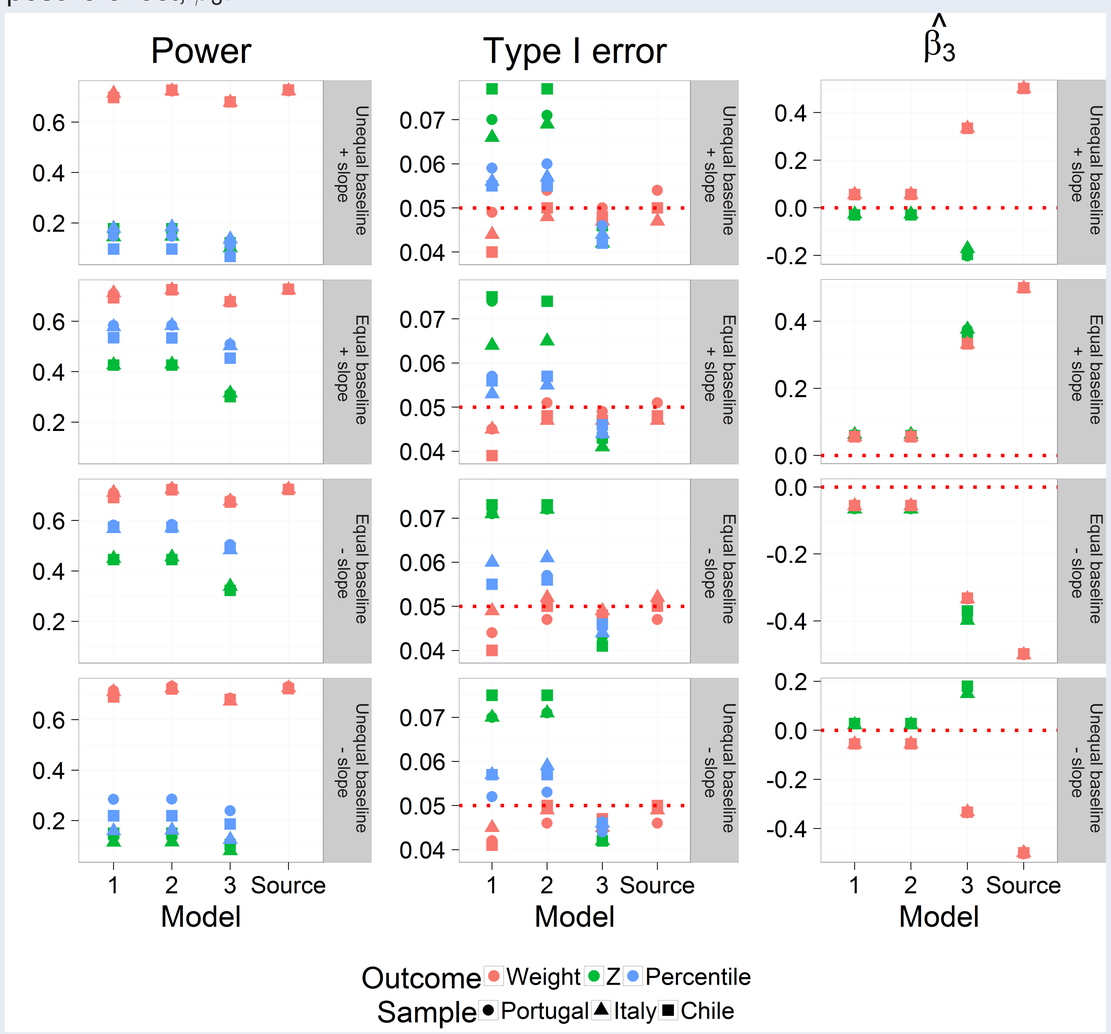


Figure 2: Comparison of power, type-I error and estimate for product term of time and exposure effect, β_3.



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.

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

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. However, these outcomes in growth trajectory analyses are not equivalent.

- 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 this measure does not function the same as crude weight when examining growth trajectories.
- Simulations presented here provide evidence for this conclusion when baseline differences in weight exists across groups.
- If reference to a standard is not a priority when examining group differences in growth trajectory patterns, crude weight measures as an outcome are most advantageous.
- In the context of growth trajectories serving as exposures in life course analyses, use of Z-scores can lead to exposure misspecification and conflicting inference if comparison to a referent such as WHO is not an aim.

vonholle@email.unc.edu