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

- 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 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 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**): $y_{ij} = \beta_0 + \beta_1 \cdot \mathtt{t} + \beta_2 \cdot \ln(\mathtt{t}_{ij}) + \frac{\beta_3}{\mathtt{t}_{ij}} + \beta_4 \cdot \mathtt{group}_i + \beta_5 \cdot \mathtt{t} \cdot \mathtt{group}_i + e_{ij}$
- After simulating weight values, we converted simulated weight to Z-score and percentiles and fit three models:

Model 1

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

Model 2

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

Model 3

$E(m_{ij}) = \beta_0 + \beta_1 \cdot \mathtt{month6} + \beta_2 \cdot \mathtt{group} + \beta_3 \cdot \mathtt{month6} \cdot \mathtt{group}$

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, 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

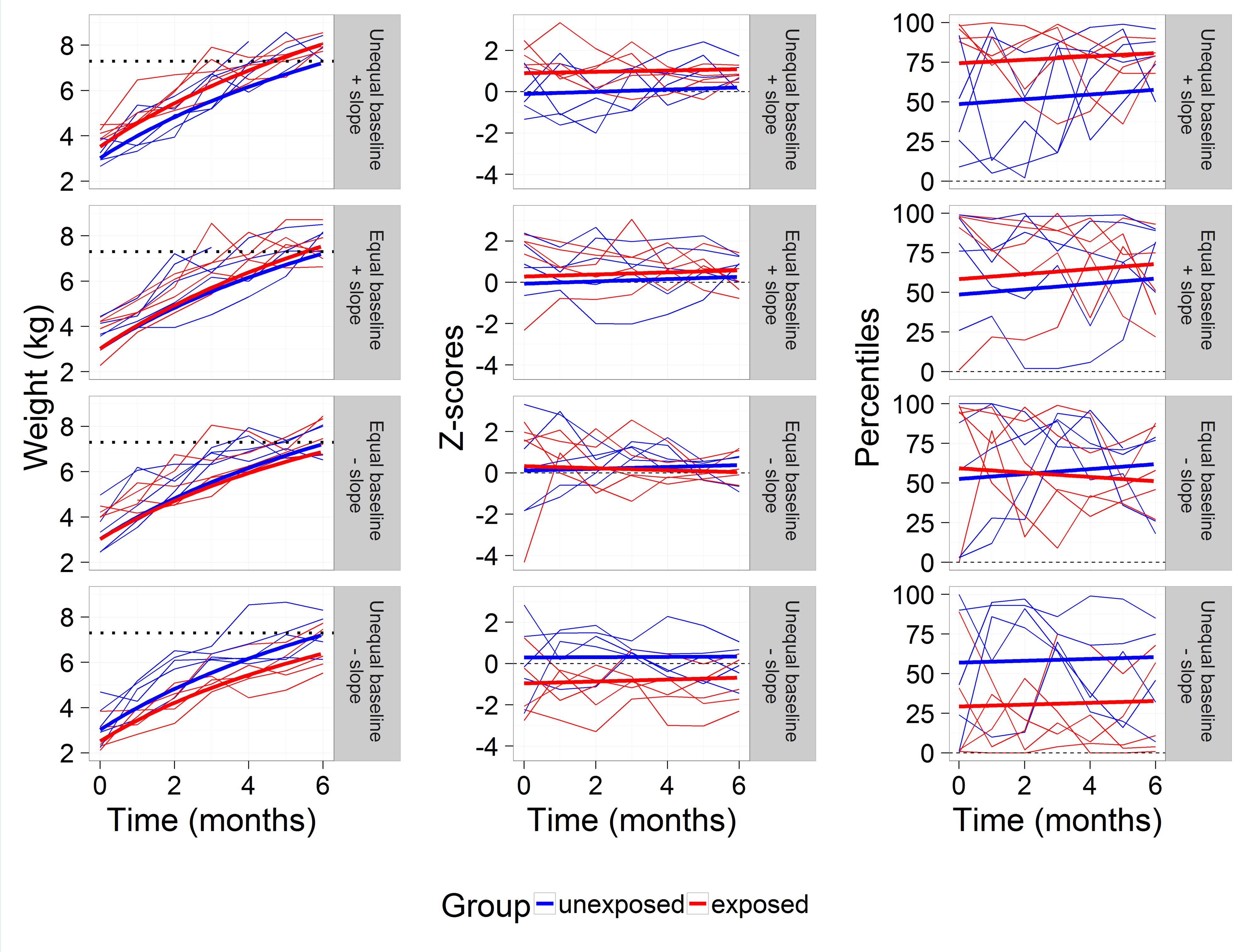
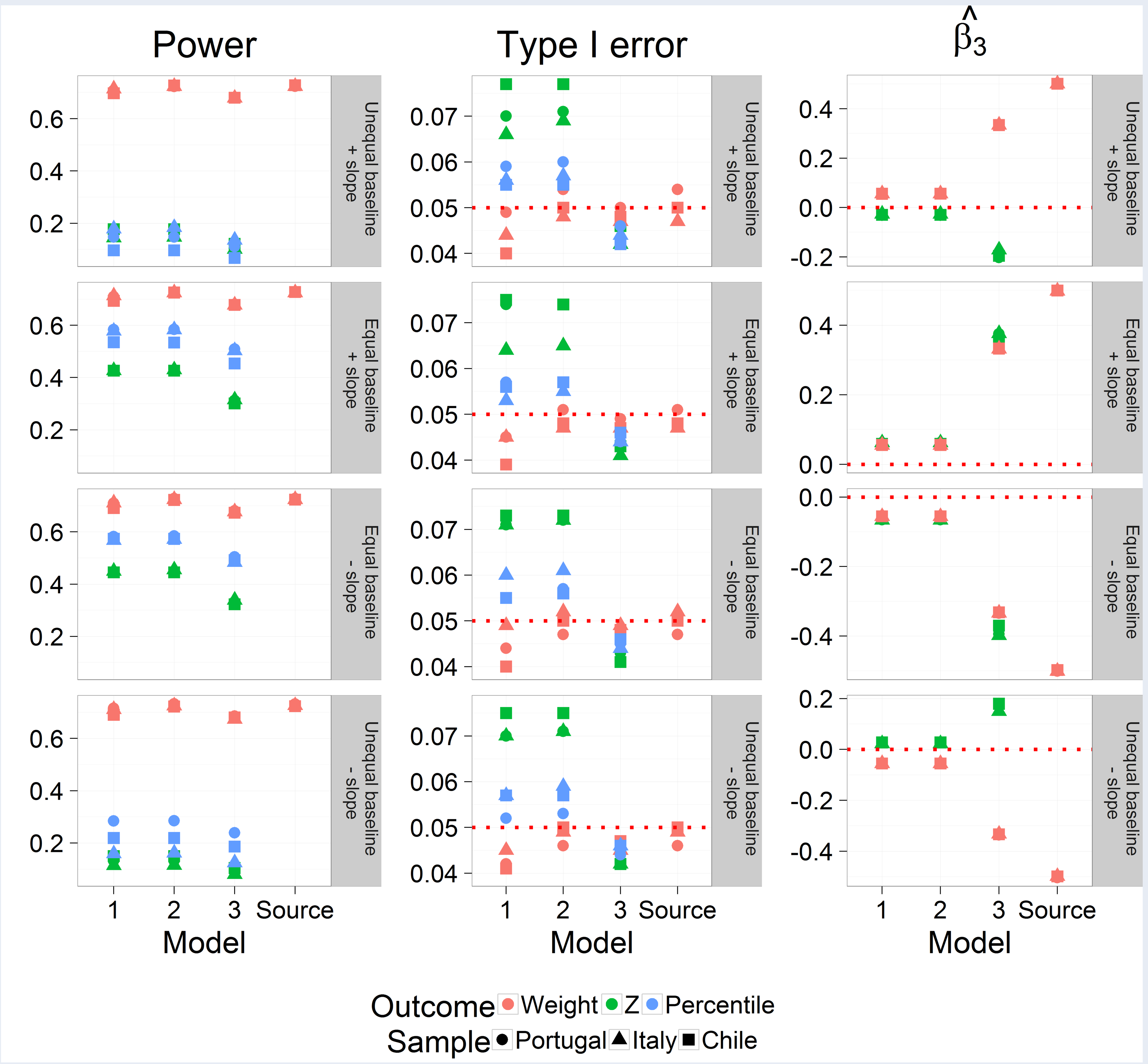


Figure 2: Comparison of power, type-I error and estimate for product term of time and exposure effect, β_3.



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.

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.

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 not applied properly can have adverse effects.

- Even at similar age and gender values, reference to a standard, such as Z-scores, is not equivalent to crude weight values when assessing group differences in weight 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 are not an objective, use of Z-scores instead of crude weight can lead to
  - ⇒ biased estimates and conflicting inference.
  - ⇒ lower power and inflated type I error.
- This finding reproduces similar work in an adolescent context. Also can extend to other contexts beside group comparisons in infant growth.
  - ⇒ 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

vonholle@email.unc.edu