Appendix.

Model for Crown Rump Length

For any given gestational age (t=i) in days, the mean log-transformed crown rump length ($\mu_{CRL}$) is $\mu_{CRL}(\text{mm})=1.9084+0.025\times t_i$.

The standard deviation ($\sigma_{CRL}$)=$0.3558–0.029\times t_i$.

Model for First Trimester Biparietal Diameter

For any given gestational age (t=i) in days, the mean log-transformed fetal biparietal diameter ($\mu_{BPD}$) is $\mu_{BPD}(\text{mm})= -0.3588+0.0528\times t_i–0.0002\times t_i^2$.

The standard deviation ($\mu_{BPD}$)=$0.06155284$.

Model for Second Trimester Biparietal Diameter

For any given gestational age (t=i) in days, the mean log-transformed fetal biparietal diameter ($\mu_{BPD}$) is $\mu_{BPD}(\text{mm})=2.1145+0.0162\times t_i–0.00003\times t_i^2$.

The standard deviation ($\mu_{BPD}$)=0.044996.

Model for Conditional Growth

Mean

For any given gestational age (t=i), the mean log-transformed fetal biparietal diameter ($\mu$) is $\mu=\alpha+\beta\times t+\gamma\times \text{gender}$…

…where t is the gestational age in days (centered at 112 days) and gender=0 if female, and gender=1 if male.

Variance

For any given gestational age (t=i), the variance (\sigma^2) of fetal biparietal diameter is $\sigma^2=\sigma^2_{\alpha}+(2\times t\times \sigma_{\alpha\beta})+(\sigma^2_{\beta}+t^2)+(2\times \text{gender}\times \sigma_{\alpha\gamma})+(2\times \sigma_{\beta\gamma}\times t\times \text{gender})+\sigma^2_e$…

…where $\sigma^2_{\alpha}$ and $\sigma^2_{\beta}$ are the variances of each parameter, $\sigma_{\alpha\beta}$, $\sigma_{\alpha\gamma}$, and $\sigma_{\beta\gamma}$ are the covariances of each pair of parameters, and $\sigma^2_e$ the within subject variance.


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Conditional reference interval

The conditional mean ($\mu_{2/1}$) and variance ($\sigma_{2/1}^2$) of a second-trimester fetal biparietal diameter measurement ($Z_2$) given a first trimester fetal biparietal diameter measurement ($Z_1$) is

$$
\mu_{2/1} (Z_2/Z_1)=\mu_2 + (Z_1-\mu_1) \frac{\sigma_{12}}{\sigma_1^2}
$$

$$
\sigma_{2/1}^2 (Z_2/Z_1)=\sigma_2^2 - \sigma_{12}^2/\sigma_1^2 \ldots
$$

...where $\sigma_{12}$ (conditional covariance) is

$$
\sigma_{12}=\sigma_a^2 + (t1 \times t2) \times \sigma_{\beta^2} + (t1 + t2) \times \sigma_{\alpha \beta} + 2 \times \text{gender} \times \sigma_{\alpha \gamma} + ((t1 \times \text{gender}) + (t2 \times \text{gender})) \times \sigma_{\beta \gamma}.
$$

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<tr>
<td>$\alpha$</td>
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<td>$-2*\log$ likelihood</td>
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SE, standard error.


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