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# Semiparametric reference curves for EDEN cohort

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## OBJECTIVES

In medicine, **reference curves** [1] [2] [6] are an important tool for clinical practice to screen for fetuses that may be of abnormal size for gestational age.

Data are from the French **EDEN** mother-child cohort [3]. As measures of child growth, we are studying fetal weight and height that depends on the gestational age, in the third trimester of mother's pregnancy.

Semi-parametric methods as **LMS methods** [4][1] and Generalized Additive Model for Location, Scale and Shape (**GAMLSS**) [5] R package are used to construct and implement these curves.

## LMS METHODS

The LMS method was developed by Cole [2] and Cole and Green [1]. Let the positive random variable  $Y$  (weight or height) be defined through the transformed random variable  $Z$  given by

$$Z = \begin{cases} \frac{1}{\sigma\nu} \left[ \left( \frac{Y}{\mu} \right)^\nu - 1 \right], \nu \neq 0 \\ \frac{1}{\sigma} \log \left( \frac{Y}{\mu} \right), \nu = 0 \end{cases},$$

with  $Y > 0$ ,  $\mu > 0$ ,  $\sigma > 0$  and  $-\infty < \nu < \infty$ .  $Z$  is assumed to follow a truncated standard normal distribution. The three parameters  $\mu$  (location parameter),  $\sigma$  (scale parameter) and  $\nu$  (skewness parameter) depend on the weeks of amenorrhea (GW) through smoothing functions  $\mu = h_1(GW)$ ,  $\log \sigma = h_2(GW)$ ,  $\nu = h_3(GW)$  with  $h_1(\cdot)$ ,  $h_2(\cdot)$  and  $h_3(\cdot)$  nonparametric smoothing functions as cubic splines. The distribution of  $Y$  is given by

$$Y \sim D(\mu, \sigma, \nu)$$

where the distribution  $D$  represent the Box-Cox Cole and Green (BCCG) distribution. Extensions of this method [5], as Box-Cox power exponential (BCPE) and Box-Cox  $t$  (BCT) are also investigated.

## EDEN COHORT

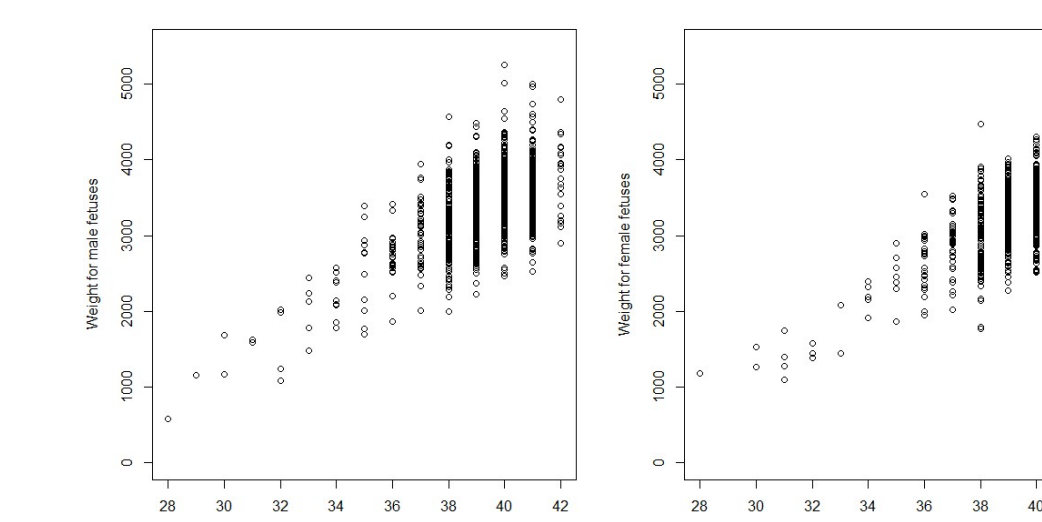
EDEN [3] is a mother-child cohort study investigating the prenatal and early postnatal determinants of child health and development. 2002 pregnant women were recruited before 24 weeks of amenorrhoea in two maternity clinics from France and from may 2003 to september 2006, 1899 newborns were then included. The main outcomes of interest are fetal and postnatal growth, adiposity development, respiratory health, atopy, behaviour and bone, cognitive and motor development.

Our interest focuses on the study of the variables weight (in grammes) and height (in centimeters)

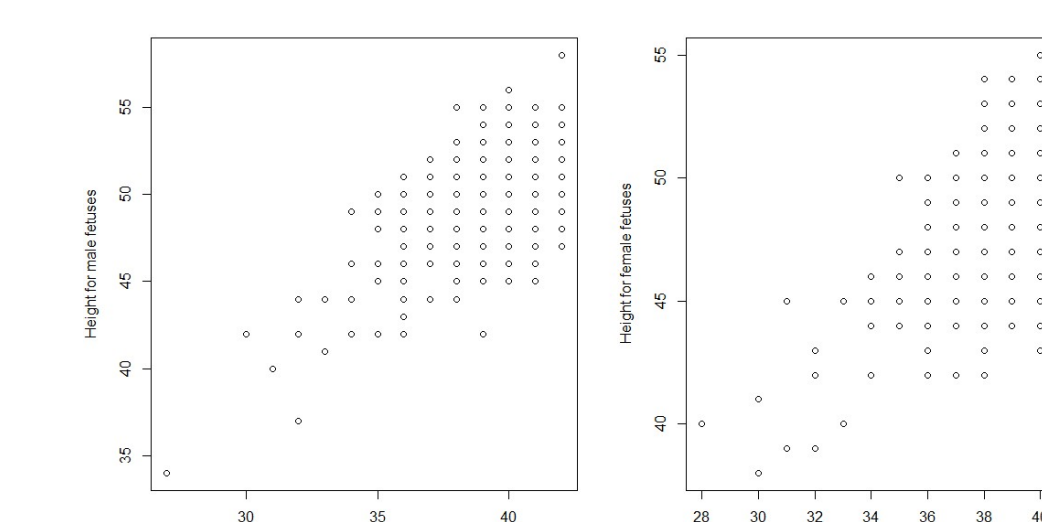
of fetuses according to the weeks of amenorrhea (GW). The data are not exact for weeks of amenorrhea less than 28 because we have few births before this date. The calculation of statistics on the data also requires to start working from 32 weeks of amenorrhea so that the data are in sufficient number. We observe that the majority of these fetuses are born for an age between 38 and 41 GW.

We acknowledge the commitment of the EDEN mother-child cohort study group and more particularly Barbara Heude which allowed us to use the data from the cohort.

## DATA AND CENTILES



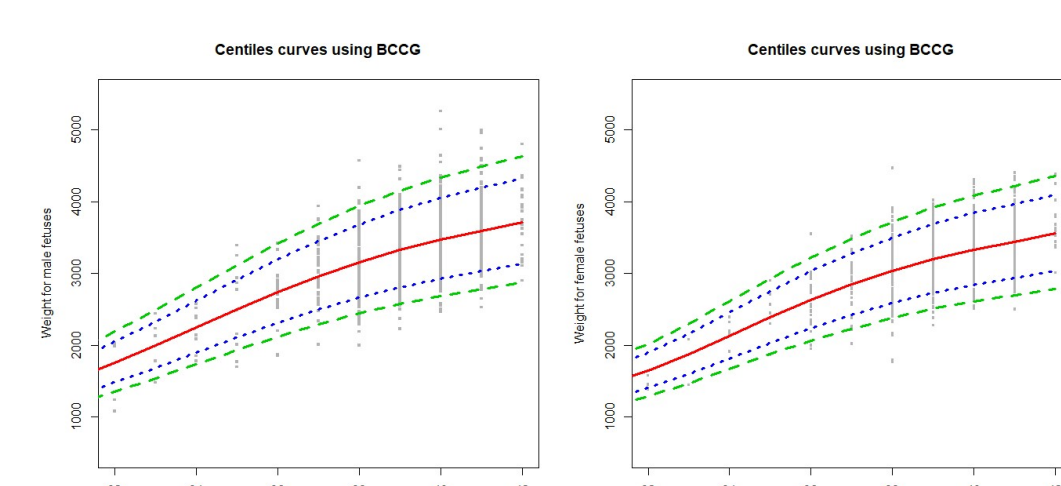
**Figure 1:** Weight for male and female fetuses from 28 to 42 gestational weeks.



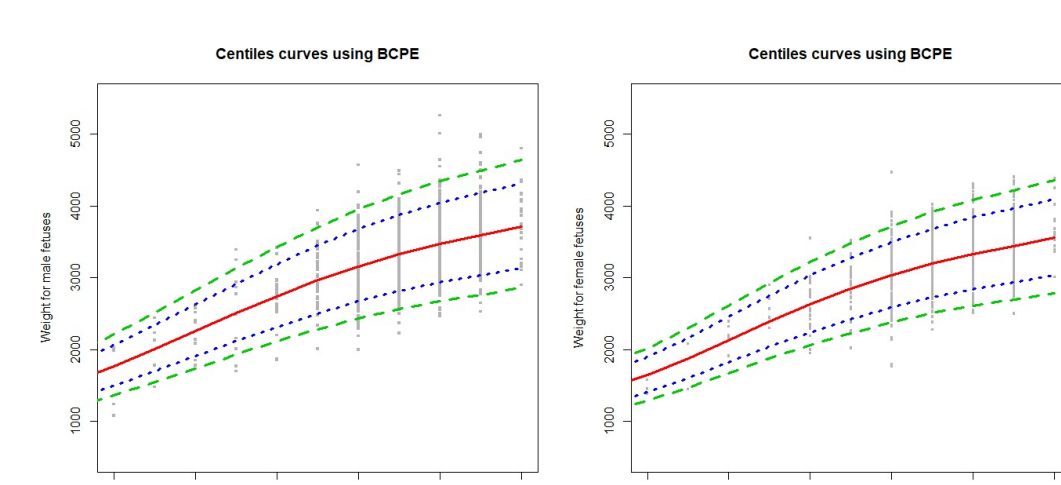
**Figure 2:** Height for male and female fetuses from 28 to 42 gestational weeks.

Centiles are usually chosen from a symmetric subset of the 3rd, 10th, 50th, 90th and 97th.

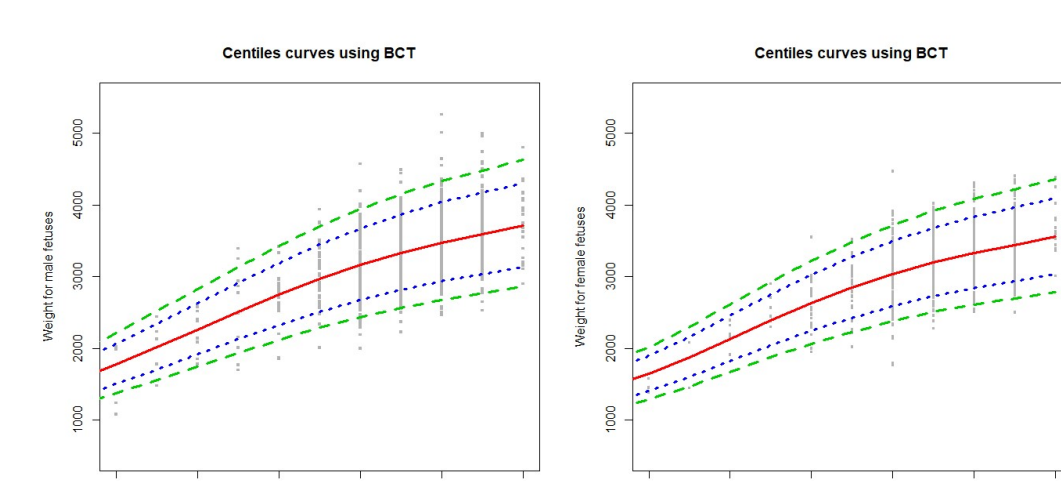
## REFERENCE CURVES FOR WEIGHT



**Figure 3:** Centiles curves using the Box-Cox and Green (BCCG) distribution for the male and female fetuses weight data and cubic splines smoothing.

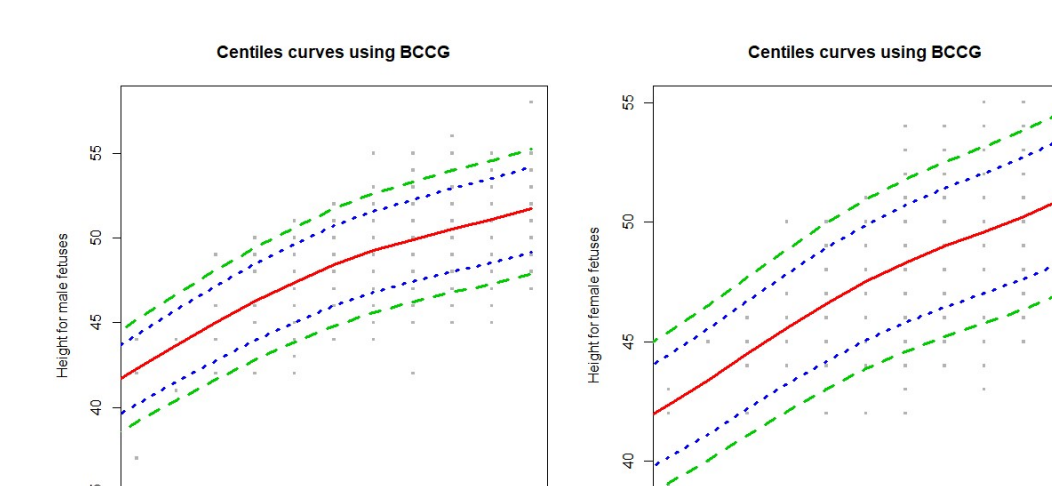


**Figure 4:** Centiles curves using the Box-Cox power exponential (BCPE) distribution for the male and female fetuses weight data and cubic splines smoothing.

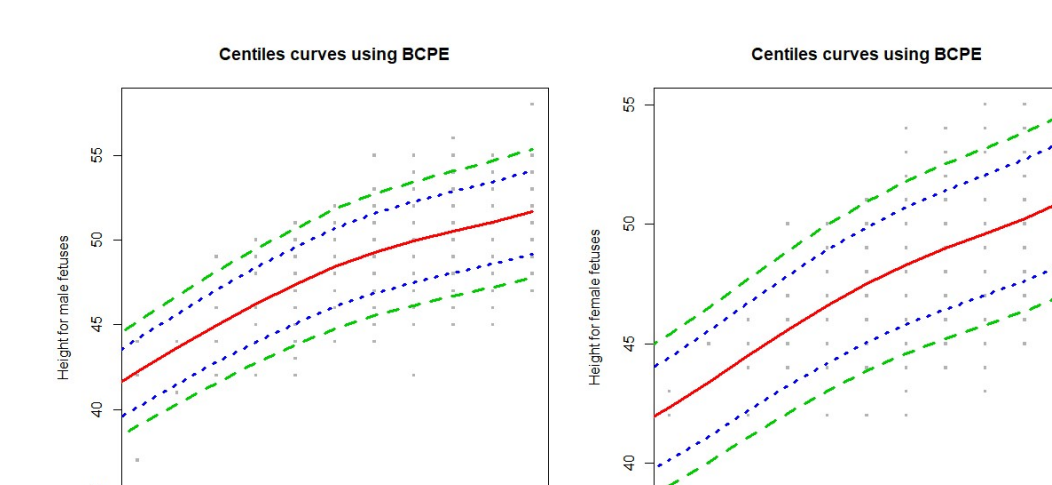


**Figure 5:** Centiles curves using the Box-Cox  $t$  (BCT) distribution for the male and female fetuses weight data and cubic splines smoothing.

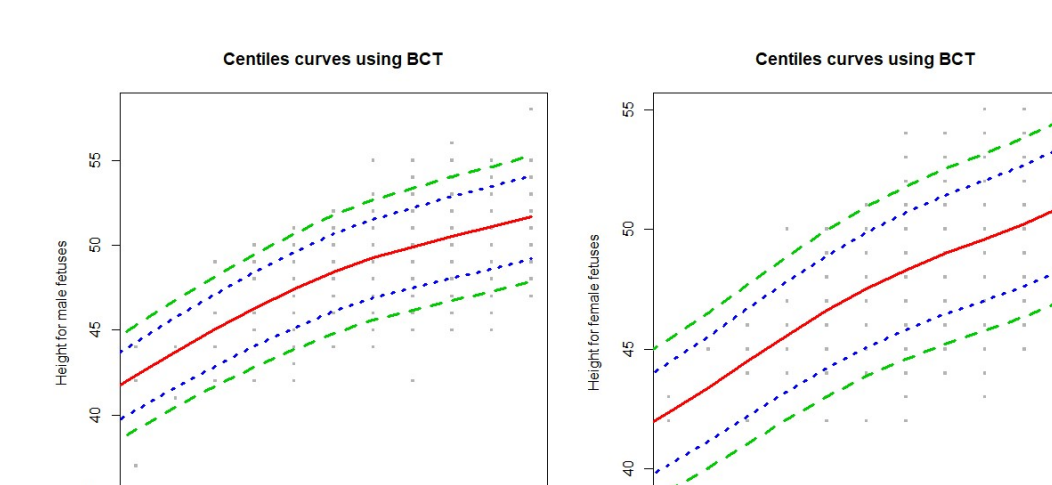
## REFERENCE CURVES FOR HEIGHT



**Figure 6:** Centiles curves using the Box-Cox and Green (BCCG) distribution for the male and female fetuses height data and cubic splines smoothing.



**Figure 7:** Centiles curves using the Box-Cox power exponential (BCPE) distribution for the male and female fetuses height data and cubic splines smoothing.



**Figure 8:** Centiles curves using the Box-Cox  $t$  (BCT) distribution for the male and female fetuses height data and cubic splines smoothing.

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