

## Effects of maternal nutrition and birth weight on regulation of energy metabolism in early life in lamb

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### Introduction:

Transition from prenatal to postnatal requires maturation of biological systems essential for survival and growth. Metabolic adaptations are necessitated by major changes in the quantity and composition of nutrients supplied to the prenatal animal. Although maternal restricted cause changes in birth weight, the association among birth weight and maternal nutrition and metabolic developments in early postnatal life is unclear.

Therefore **the object** of this study was to investigate the effect of maternal nutrition and birth weight on endocrine and metabolic developments during early life in lamb.

### Method:

23 lambs ( 11 female and 12 male) born in dams with three different nutritional background concerning to their grandmothers and mothers nutrition during late gestation (*Adlibitum-Adlibitum*, *Adlibitum-Restricted*, *Restricted-Restricted*) subjected to the trial. At birthday and 7, 17, 35 days *postpartum* lambs were weighted. furthermore, blood sample were withdrawn at the mentioned times. blood Samples analyzed for plasma Glucose and insulin concentration. The ratio of insulin to glucose were calculated in order to be used as an indicator of glucose tolerance in lambs in early life.

### Experimental Design :

Experiment was conducted as a completely random design repeated in four times(1, 7, 17, 32 days *postpartum*). A hierarchical multilevel model (dam-lamb-age) was structured to analysis the data. Table 1. shows the predictors.

Table 1.

Independent variables		Levels		
Lamb ID	Lamb	995-1023		
Dam ID	Dam	724-839		
Grandmother ID	Grand	613-8856		
Body weight	BW	continues		
Birth weight	BW1	Continues		
AGE(day)	AGE	1,7,17,32 days		
Grand nutrition	G2	<i>Ad lib</i> (A)	Restricted (R)	0/1
Mother nutrition	G1	<i>Ad lib</i> (A)	Restricted (R)	0/1
Gender	SEX	Female(F)	Male (M)	0/1

### Checking model assumption and Statistical analysis:

A hierarchical multilevel response model with three levels (dam-lamb-age) were used to analysis the data. Having checked the raw data, it turns outs that variation among the time(age) is not the same. Besides observations were right skewed.(figure1,2).

To over come these problems , several data transformation were tested. . Urning log transform for the response was satisfying .(figure 3,4,5,6)

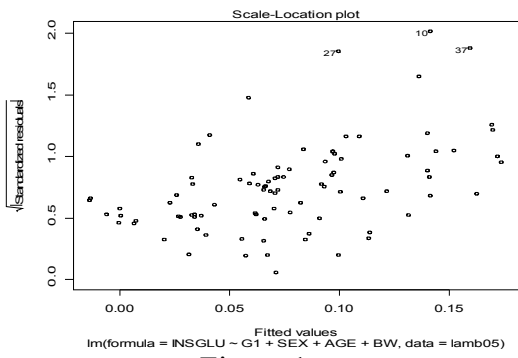


Figure 1.

Figure 2.

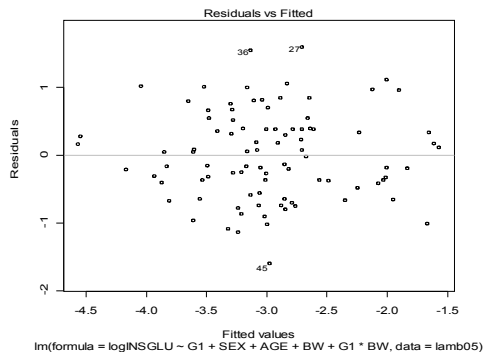


figure 3.

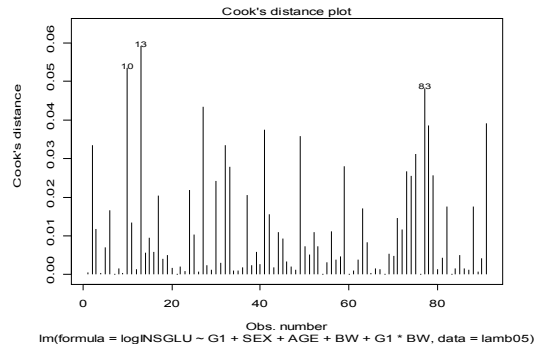


figure 4.

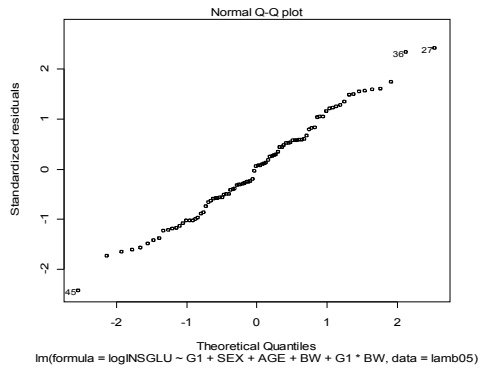


figure 5.

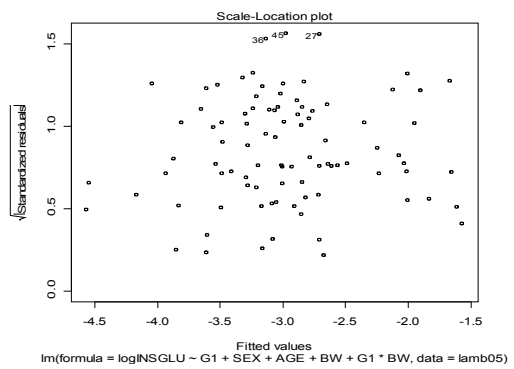


figure 6.

.Using Mlwin software several predictor were tested with MCMC method. Following model is the final which includes all predictors and is the most fitted.

$$\text{logins-glu}_{ijk} \sim N(XB, \Omega)$$

$$\text{logins-glu}_{ijk} = \beta_{0ijk} \text{cons} + 1.073(0.257)\text{Adlib}_k + -0.286(0.166)\text{birtv}_{jk} + -0.084(0.018)\text{AGE}_{ijk} + 0.276(0.081)\text{bw-m}_{ijk} + -0.039(0.013)\text{Adlib.AGE}_{ijk} + 0.386(0.179)\text{male}_k$$

$$\beta_{0ijk} = -2.935(0.610) + v_{0k} + u_{0jk} + e_{0ijk}$$

$$\begin{bmatrix} v_{0k} \end{bmatrix} \sim N(0, \Omega_v) : \Omega_v = \begin{bmatrix} 0.068(0.091) \end{bmatrix}$$

$$\begin{bmatrix} u_{0jk} \end{bmatrix} \sim N(0, \Omega_u) : \Omega_u = \begin{bmatrix} 0.054(0.076) \end{bmatrix}$$

$$\begin{bmatrix} e_{0ijk} \end{bmatrix} \sim N(0, \Omega_e) : \Omega_e = \begin{bmatrix} 0.355(0.080) \end{bmatrix}$$

*Deviance(MCMC) = 168.876(95 of 97 cases in use)*

### Variance partition coefficient (VPC)

Dam level  $(0.068/(0.068+0.054+0.355))= 0.14$  14%  
 lamb level  $(0.054)/(0.068+0.054+0.355)=0.11$  11%

### Intra-class correlation coefficient (ICC)

Observation of same lamb  $= (0.054+0.068)/(0.068+0.054+0.355)=0.25$  25%  
 Observation of same dam (twins)  $= (0.054)/(0.068+0.054+0.355)=0.11$  11%

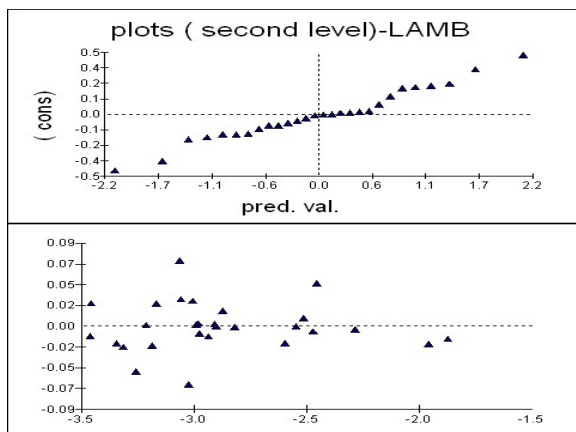


Figure7.

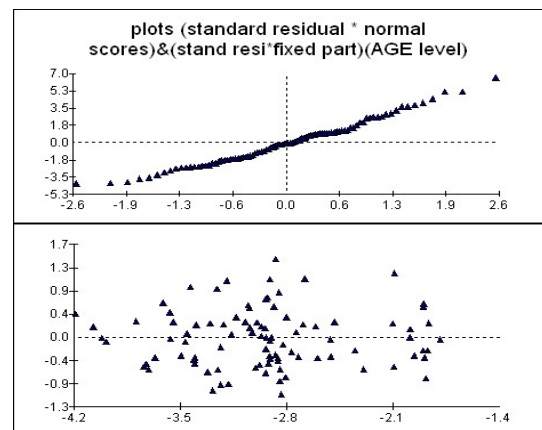


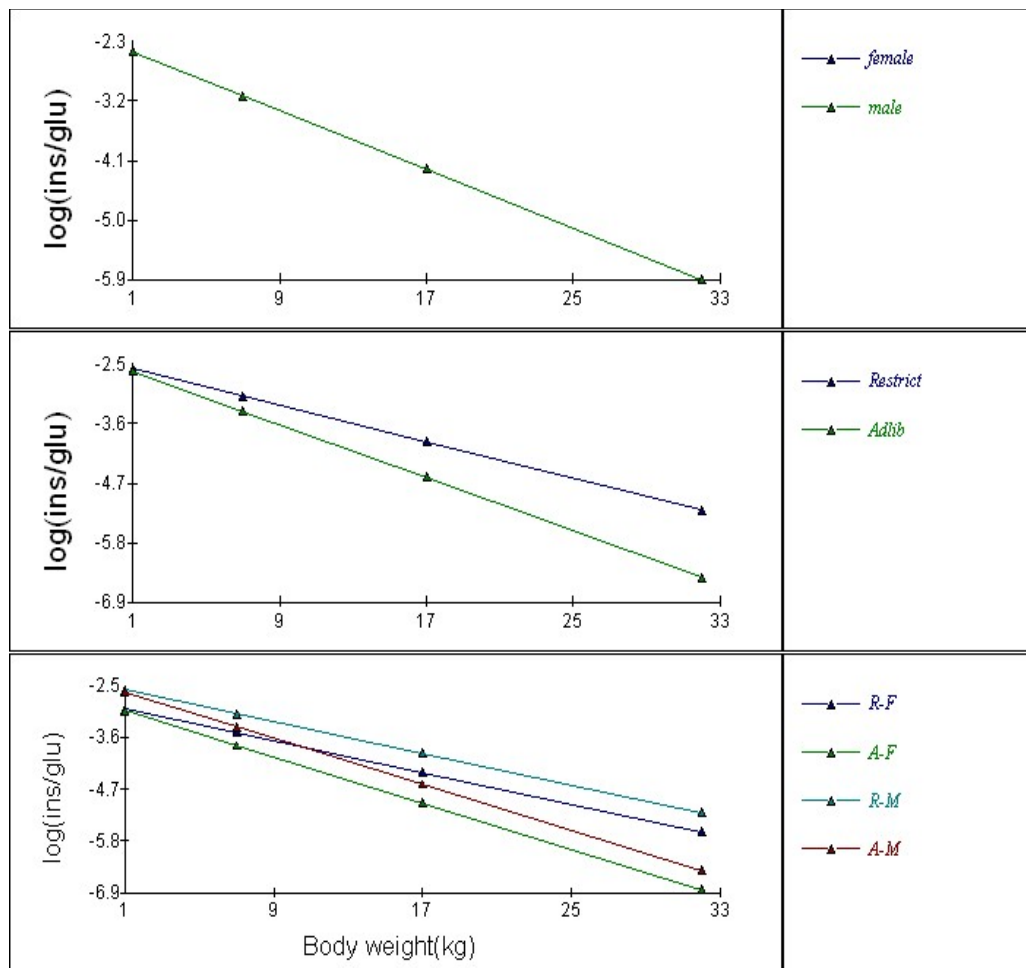
figure 8.

### Plots and model diagnostics:

Both sets of residuals (figure 7,8) look reasonably normal at the lowest level (age) but in the lamb level residuals look a little strange. Perhaps it is due to missing values and two outliers which are included in the data. It could be helpful to refit the model with and without the outliers.

### Result and discussion :

Based on the result, it is concluded that maternal nutrition has a significant effect on endocrine and metabolic developments in early life. It should be kept in mind that the conclusion deals just with the ratio between plasma insulin and glucose concentration (INS/GLU).



Lambs born in restricted mothers showed lower ratio of INS/GLU. Besides it is concluded that maternal nutrition rather than birth weight has more influence on endocrine developments in early life in lambs. Although no significant difference was found between males and females (figure 9.) it seems that female lambs with restricted mothers act kind of different from other groups.

