



# Maternal backfat and gestation feed level on offspring



# Nutrition in early life permanently alters metabolism of offspring

## Obesity, cardiovascular health, diabetes



*European Journal of Clinical Nutrition* , (1 March 2017) | doi:10.1038/

### Relationship between prenatal growth, postnatal growth and childhood obesity: a review

E K Matthews, J Wei and S A Cunningham

300,000 kids obese in Ireland



International Journal of  
Environmental Research  
and Public Health

Review

### Nutrition in the First 1000 Days: The Origin of Childhood Obesity

Chiara Mameli, Sara Mazzantini and Gian Vincenzo Zuccotti \*

### Pregnant? Keep Steady with Low-Glycemic Foods Simple swaps can keep you and baby healthy.

Expecting moms know they should eat nutritious foods, but they may not know that low glycemic foods are very beneficial. These foods are digested more slowly and keep blood sugar levels steady, which may help to reduce pregnancy weight gain and the risk of gestational diabetes. And reducing these risks helps both mom and baby. Making the change to low glycemic foods is easy with simple swaps.

#### Craving This?

#### Try This!

##### Grains



Bagel



Irish or Steel Cut Oatmeal

##### Fruits



Watermelon



Apples, Plums or Orange

##### Vegetables



White Potato or Corn



Zucchini or Avocado

##### Proteins



Cheeseburger



Chicken Breast

##### Dairy



Ice Cream



Greek Yogurt

**Smart Food Tip:** In a hurry? Prepare hard boiled eggs or dip and veggie sticks ahead of time.

Source: Abbott



nutrition now, matters forever



Nestlé

### The First 1,000 Days: Nestlé Infant Nutrition product solutions



Pregnancy

0-6 Months

6-8 Months

9-11 Months

12-23 Months

<p>Maternal Nut</p> <p>Materna</p>	<p>Breastfeeding is Best</p> <p>Premature</p>	<p>Infant Formula &amp; GUMs</p> <p>Infant Cereals</p> <p>Meals &amp; Drinks</p>
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## Weight pre-pregnancy?

*USA: 50% of pregnant woman are overweight at the outset of pregnancy*

*No consensus in EU*

*No WHO recommendation*

*Excessive weight gain is prevalent*

*USA 2013: adequate weight gain was 32.1%, excessive weight gain = 47.5%*

## Gestational weight gain for overweight woman?



Pre-pregnancy weight	Recommended weight gain
Normal weight (BMI 18.5 to 24.9)	37 to 54 lbs. (about 17 to 25 kg)
Overweight (BMI 25 to 29.9)	31 to 50 lbs. (about 14 to 23 kg)
Obese (BMI 30 or more)	25 to 42 lbs. (about 11 to 19 kg)

USA Inst. Med



**Litters  
Self limit  
-food intake**

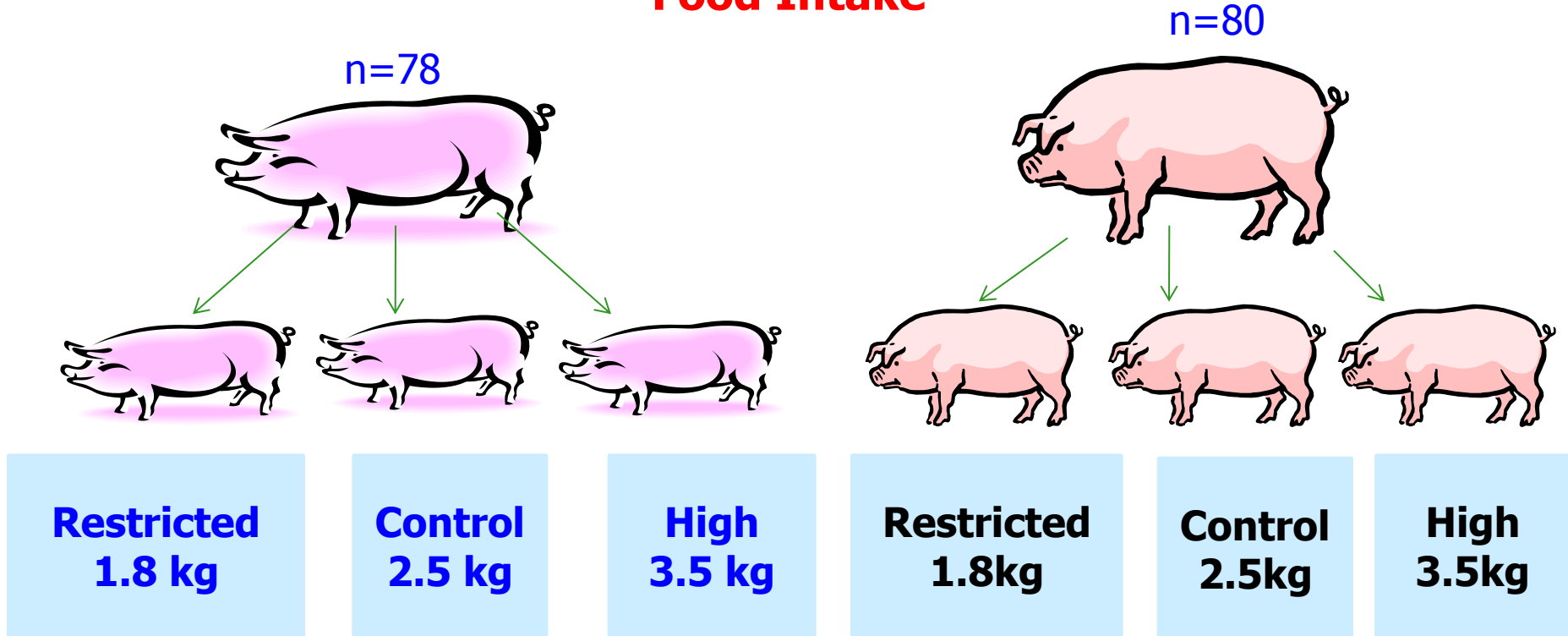


**ruminants**



**Meal eating  
Digestive tract  
Cardiovascular  
Organ sizes  
Do not self limit**

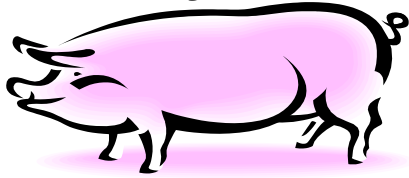
# Overweight pre-pregnancy? Gestational weight gain? Food Intake



**425 individual offspring at different life stages?**

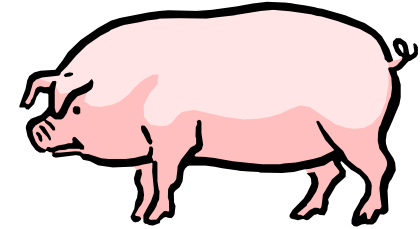
**STATISTICS: mixed models SAS  
Fixed/random effects, covariates  
depend on sow or offspring data**

Backfat  
7-9mm



**Gilts selected @ 22 weeks  
F1 Large white X landrace**

10-12mm

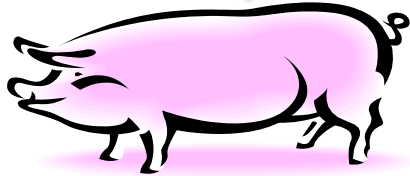


Restricted  
1.8kg/dry sow diet

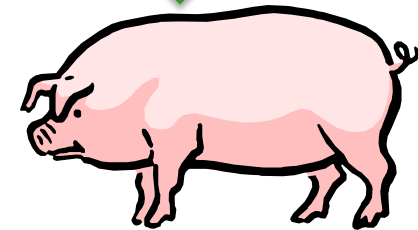


**32 weeks  
insemination**

*Ad libitum*  
Gilt diet

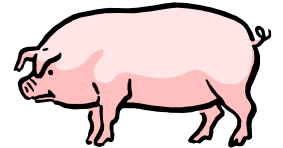
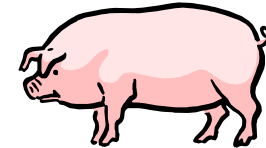
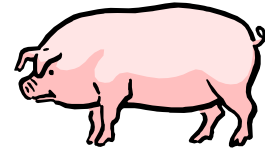
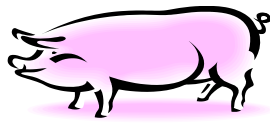
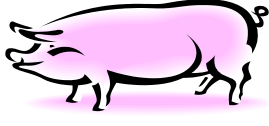
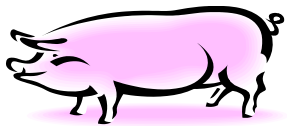


12mm



20mm

Day 25-90 gestation



**Restricted  
1.8 kg**

**Control  
2.5 kg**

**High  
3.5 kg**

**Restricted  
1.8kg**

**Control  
2.5kg**

**High  
3.5kg**

**All received same lactation diet**



- **Litters were standardized at birth by cross fostering within treatment groups**
- **Representatives of LBW (<1.2kg), MBW (<1.5kg), HBW (>1.7kg)**
- **Males and females**
- **155 piglets sacrificed d28 weaning**
- **270 adult offspring day130pw**





# Interactions: gilt body condition X gestational feed levels X offspring birth weight

## Weight pre-pregnancy (Fat V Thin gilts)

Treatment	Thin			Fat			SEM	P†	
	1.8 kg	2.5 kg	3.5 kg	1.8 kg	2.5 kg	3.5 kg		Body condition	Feed level
<i>n</i>	9	14	14	12	15	13			
Fatty acid composition (g/100 g of FAME) of milk day 21*									
C4 : 0	0.11	0.06	0.05	0.05	0.08	0.02	0.041	0.427	0.395
C10 : 0	0.18	0.15	0.14	0.17	0.12	0.10	0.020	0.035	0.005
C12 : 0	0.26	0.22	0.22	0.25	0.18	0.17	0.023	0.010	0.006
C14 : 0	3.41	3.04	3.13	3.19	2.69	2.42	0.216	0.004	0.014
C14 : 1 c9	0.32	0.22	0.23	0.23	0.17	0.18	0.033	0.005	0.018
C15 : 0	0.100	0.102	0.092	0.097	0.080	0.071	0.0095	0.014	0.099
C16 : 0	32.40	31.12	31.42	31.36	29.47	27.08	1.461	0.018	0.113
C16 : 1 c9	11.97	9.44	9.36	9.47	8.37	7.84	1.018	0.023	0.052
C17 : 0	0.20	0.24	0.23	0.21	0.23	0.21	0.018	0.388	0.144
C17 : 1 c7	0.31	0.34	0.31	0.29	0.31	0.24	0.030	0.050	0.187
C17 : 1 c10	0.33	0.35	0.47	0.43	0.35	0.28	0.104	0.584	0.886
C18 : 0	3.06	3.91	3.82	3.57	4.02	4.49	0.295	0.045	0.006
C18 : 1 total	25.4	28.6	30.0	27.9	30.3	33.9	1.85	0.020	0.015
C18 : 2 t9, t12 n-6	1.63	1.79	1.73	1.73	1.67	1.80	0.097	0.888	0.656
C18 : 2n-6	16.4	16.1	15.8	16.8	17.5	16.5	0.90	0.159	0.637
C18 : 3n-6	0.06	0.09	0.07	0.08	0.08	0.12	0.024	0.281	0.571
C18 : 3n-3	1.62	1.55	1.55	1.65	1.71	1.62	0.091	0.131	0.784
c9, t11 CLA	0.05	0.06	0.05	0.07	0.07	0.07	0.009	0.077	0.680
C20 : 2	0.19	0.27	0.27	0.21	0.26	0.38	0.045	0.200	0.010
C20 : 3n-6	0.21	0.30	0.27	0.32	0.33	0.38	0.044	0.009	0.286
C20 : 4n-6	0.38	0.51	0.39	0.45	0.47	0.50	0.048	0.229	0.181
C22 : 5n-3	0.13	0.15	0.15	0.13	0.16	0.15	0.019	0.627	0.366
C22 : 6n-3	0.011 <sup>a</sup>	0.037 <sup>b</sup>	0.021 <sup>a,b</sup>	0.026 <sup>a,b</sup>	0.024 <sup>a,b</sup>	0.028 <sup>a,b</sup>	0.0075	0.551	0.185
C24 : 0	0.06	0.05	0.05	0.06	0.08	0.05	0.021	0.733	0.609
Total unsaturated	59.19	60.11	59.85	60.00	61.92	64.09	1.433	0.017	0.154
Total saturated	39.85	38.96	39.22	39.02	37.02	34.69	1.475	0.014	0.146
Total n-3	1.81	1.83	1.78	1.90	1.97	1.87	0.106	0.141	0.697
Total n-6	18.70	18.80	18.27	19.40	20.09	19.25	0.958	0.120	0.669
Ratio unsaturated:saturated	1.52	1.58	1.56	1.58	1.71	1.89	0.113	0.022	0.192
Ratio n-6:n-3	10.35	10.35	10.28	10.24	10.26	10.33	0.193	0.708	0.992

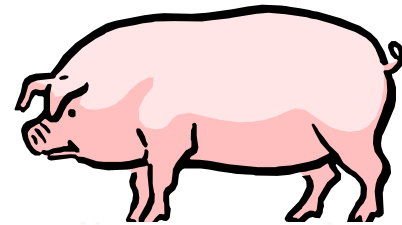
**P\***  
 dition      Feed level  
 0.881  
**Fat gilts**  
**>% fat in milk**  
**Less sat fat**  
**C10, C12, C14**  
**More unsat fat**  
**C18, C20**  
**Ratios:**  
**1.73:1 V 1.55:1**



# Weight pre-pregnancy (Fat V Thin gilts)

Treatment	Thin gilt			Fat gilt			s.e.m.	P-values	
	1.8 kg	2.5 kg	3.5 kg	1.8 kg	2.5 kg	3.5 kg		Gilt body condition	Gilt feed level
Pigs on trial	41	37	56	52	47	40			
Pig weight (kg)									
Birth	1.39	1.49	1.47	1.49	1.49	1.49	0.05	*	
Weaning	7.4	6.8	7.0	7.5	7.4	7.4	0.6		
Day 14 pw	10.4	9.8	9.7	10.7	10.5	10.5	0.8		
Day 28 pw	16.0	17.2	14.9	17.7	17.5	16.8	1.3	*	
Day 49 pw	29.2	30.4	27.0	30.7	30.3	29.3	2.0	†	
Day 91 pw	59.4	62.2	60.2	64.3	63.7	62.9	4.0	†	
Day 130 pw	92.0	95.8	93.4	97.9	98.8	96.8	4.7	*	

**Fat mothers = heavier offspring**  
**Offspring were fatter & less muscle**

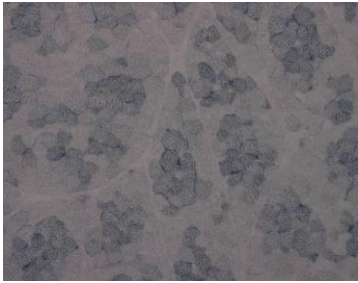


Carcass quality	1.8 kg	2.5 kg	3.5 kg	1.8 kg	2.5 kg	3.5 kg	s.e.m.	P-values
Carcass weight (kg)	70.2	73.0	72.0	74.5	75.4	76.3	3.7	†
Dressing out (%)	76.3	76.0	76.2	76.3	76.5	76.5	0.7	
Backfat (mm)	10.9	10.0	11.2	12.6	11.4	11.8	1.1	*
Muscle depth (mm)	48.5	47.6	50.2	50.7	50.2	51.5	2.1	
Lean meat (%)	58.2	58.9	58.3	57.1	58.0	58.0	0.9	*

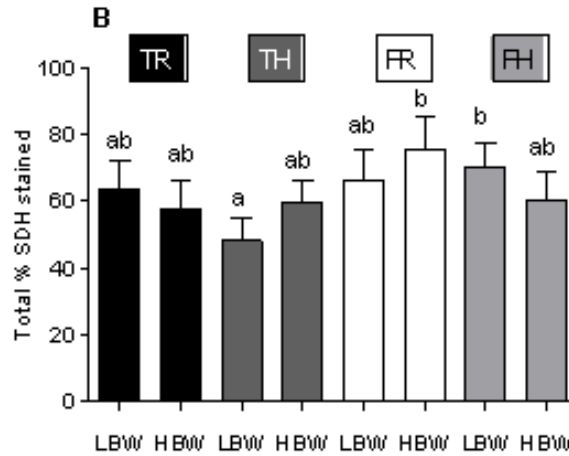
***m.semitendinosus* muscle lighter weaning**



***Amdi et al. Animal 2014, 8:2:236-244***

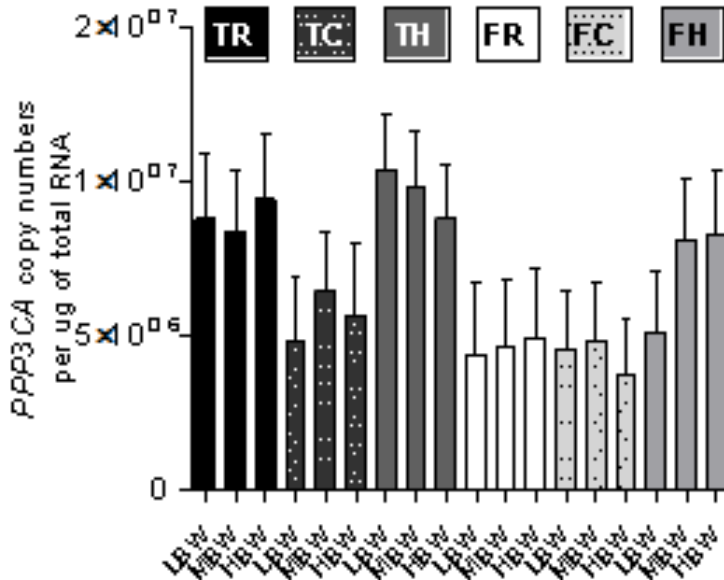


## Piglets born to fat mothers



*m.semitendinosus*  
 >succinate dehydrogenase  
 Higher oxidative capacity

## Less mRNA transcripts *calcineurin*



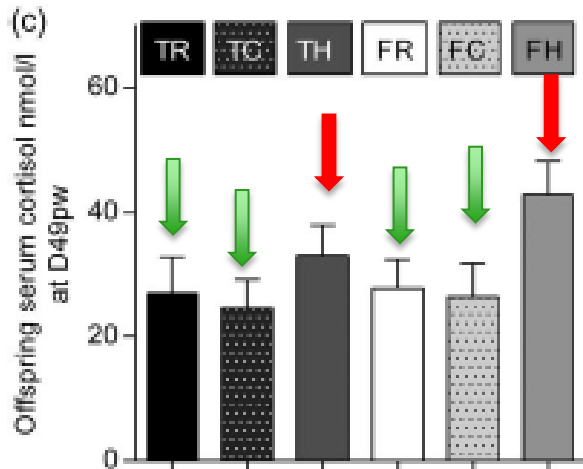
No effect  
 adipokines, inflammation  
 biomarkers

# Gestational food intake

Treatment	Thin	Fat	SEM	<i>P</i> *	Restricted	Control	High feed	SEM	<i>P</i> *
<i>n</i>	68	72			44	48	48		
Litter size									
Litter birth weight (kg)	16.5	17.3	0.49	0.25	17.1	16.5	17.0	0.62	0.72
Total number born	12.1	12.7	0.38	0.64	13.0	11.9	12.3	0.48	0.20
Number born alive/litter	11.4	11.9	0.38	0.89	12.4 <sup>a</sup>	11.1 <sup>b</sup>	11.4 <sup>a,b</sup>	0.49	0.04
Number born dead/litter	0.76	0.80	0.130	0.59	0.64	0.80	0.90	0.165	0.51
Number of pre-weaning deaths per litter	1.79	1.98	0.229	0.52	1.87	2.14	1.64	0.287	0.43
Total number weaned/litter†	10.1	9.9	0.22	0.17	10.4	9.7	9.9	0.27	0.21

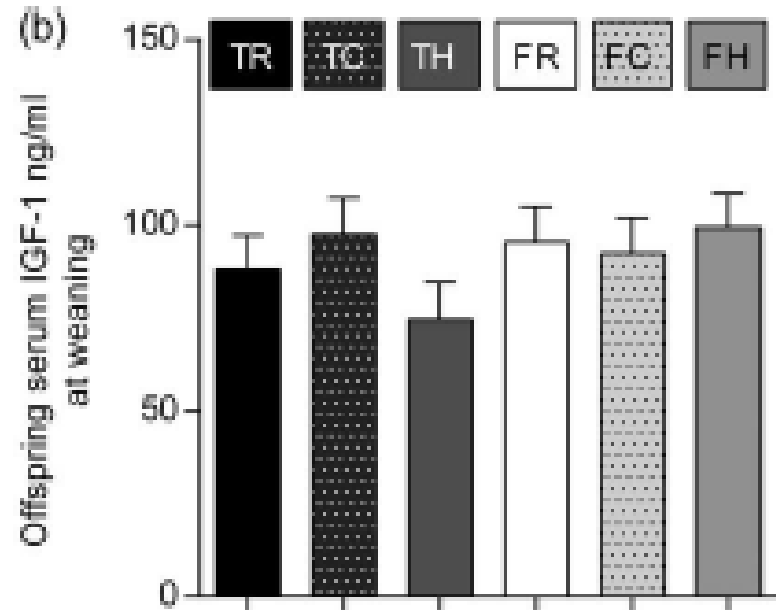
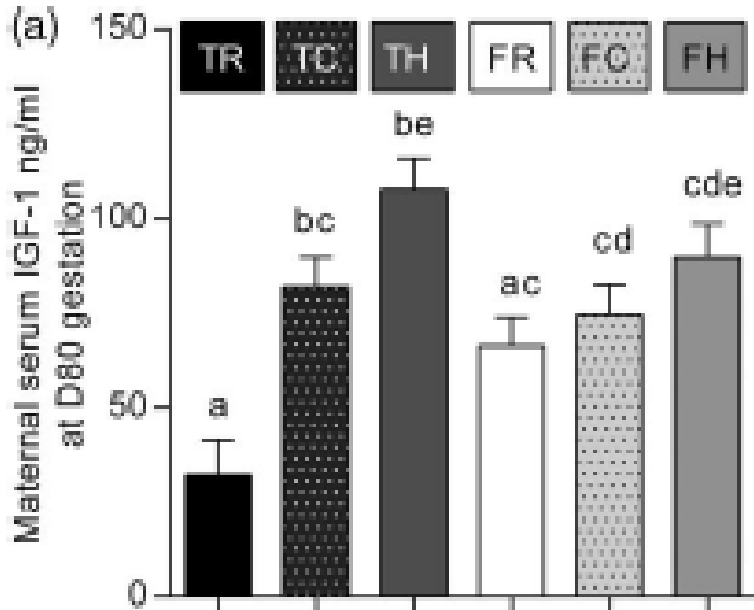
## Day 80 gestation cortisol

Treatment	Thin			Fat			SEM	<i>P</i> *	
	1.8 kg	2.5 kg	3.5 kg	1.8 kg	2.5 kg	3.5 kg		Body condition	Feed level
<i>n</i>	21	23	24	23	25	24			
Cortisol (nmol/l)	9.27	7.03	5.79	7.78	6.44	4.21	0.912	0.081	0.001



**High feed levels = high cortisol in offspring (opposite of mothers!)**

# Gestational food intake



## Maternal IGF-1

49.2ng/ml (restricted gilts)

78.4ng/ml (control)

98.8ng/ml (high)  $p < 0.001$



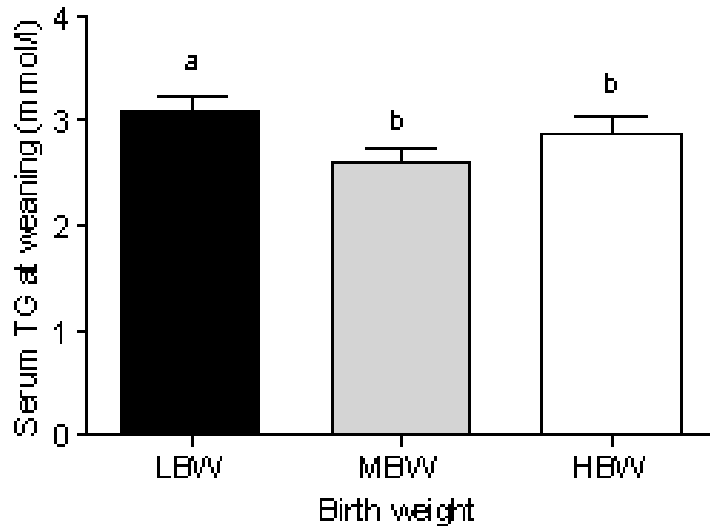
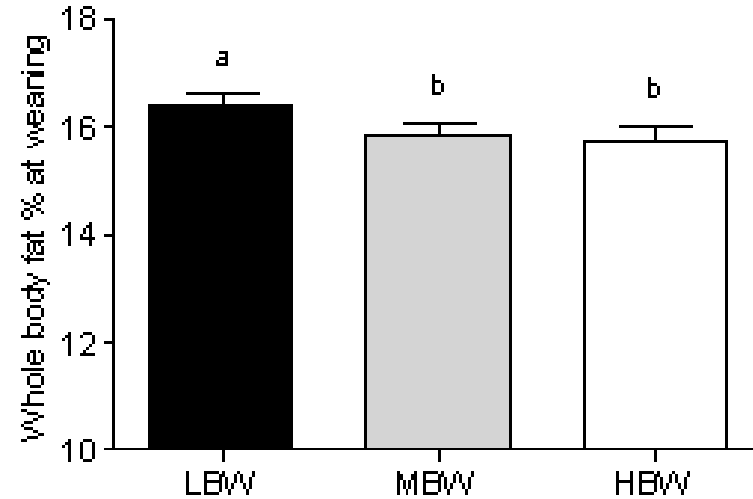
adipose

>IL-6 in offspring

Restricted gilts



# Birth weight influenced body fat %

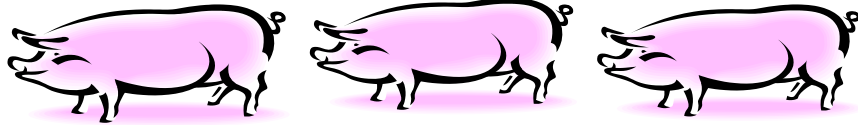
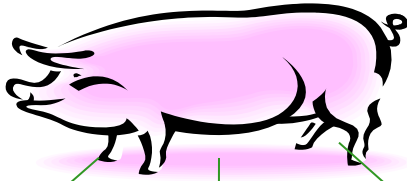


Birth weight

**LBW lowest  
adiponectin  
( $P < 0.05$ )  
(energy  
balance,  
glucose)**



78

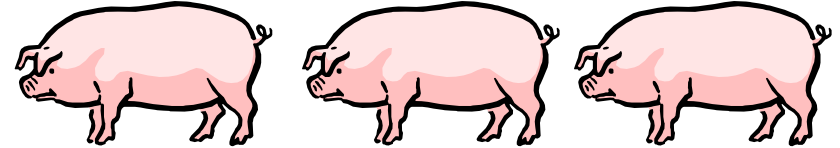
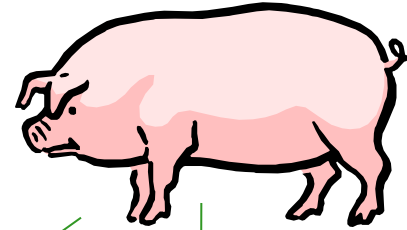


**Restricted**  
**1.8 kg**

**Control**  
**2.5 kg**

**High**  
**3.5 kg**

80



**Restricted**  
**1.8kg**

**Control**  
**2.5kg**

**High**  
**3.5kg**



>425 offspring

# Overweight pre-pregnancy? Gestational weight gain?



- **Interactions: gilt body condition X gestational feed levels X offspring birth weight x gender**
- **weight pre-pregnancy influenced milk fat % & fat composition, offspring weight, muscle (weight, oxidative capacity, serine phosphatase)**
- **Gestational weight gain influenced mother IGF-1, born alive, cortisol levels in mothers and offspring, offspring adipose (eg inflammation)**
- **Birth weight offspring body fat %**

