



# Metabolic Responses to Glucose Infusion in Estonian Holstein Cows of Different Body Condition

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# Introduction

- Dairy farming is a big part of Estonian agriculture
- During the last 14 years Estonian farms` average milk production has increased 270 kg per year
- This has brought along higher frequency of metabolic diseases
- Insulin has a central role in coordinating metabolism in transition period, success in breeding has led to increased insulin resistance
- Insulin resistance - reduced pancreas response and sensitivity of peripheral tissue
- Intravenous glucose tolerance test is one way to assess insulin resistance

# Hypothesis and objective

## **Hypothesis:**

The metabolic status and insulin resistance depend on the amount of cows` fat reserves in dry period.

## **Objective:**

To evaluate the response of metabolites characterizing carbohydrate and lipid metabolism to glucose infusion in Estonian Holstein dairy cows.

# Materials and methods

- Holstein dairy cows (n=44, average milk production 9000 kg), grouped according to BCS at dry period:
  1. Thin (n=15): BCS  $\leq$  3.0
  2. Optimal (n=14): BCS = 3.25 - 3.5
  3. Fat (n=15): BCS  $\geq$  3.75

- Loose housing, milked twice a day, fed TMR

- BCS mean values:

|                    | Thin | Optimal | Fat  |
|--------------------|------|---------|------|
| Before parturition | 2.83 | 3.34    | 3.88 |
| After parturition  | 2.50 | 2.80    | 3.16 |

# Materials and methods

## Intravenous glucose tolerance test (GTT):

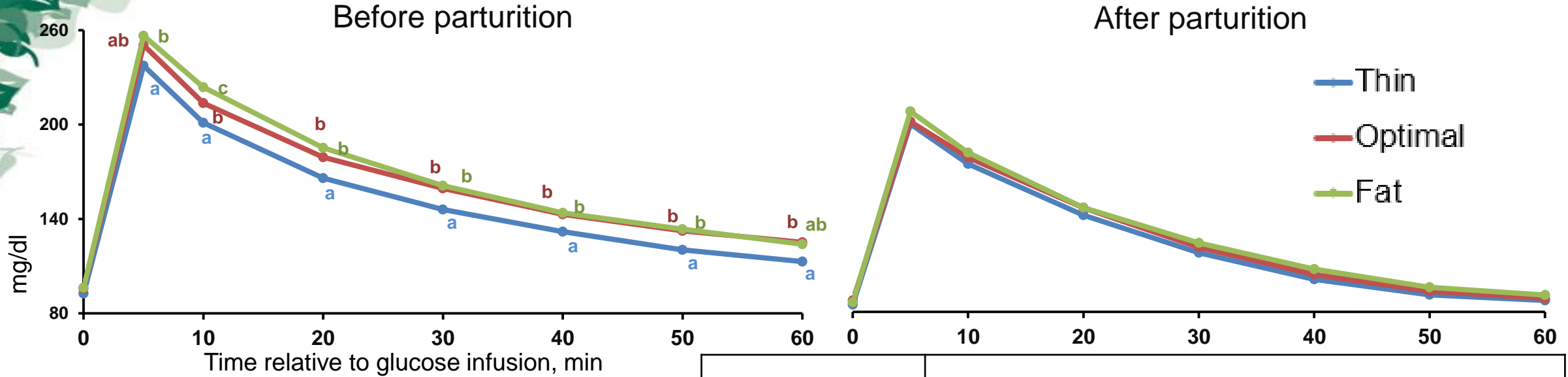
- Tests were carried out three weeks before and after the parturition, approximately 10 pm
- Blood samples were collected at -5, 5, 10, 20, 30, 40, 50, 60 minutes
- Glucose, insulin, nonesterified fatty acids (NEFA) and  $\beta$ -hydroxybutyrate (BHB) concentrations were analysed
- Increment, clearance rate (CR), half-time ( $T_{1/2}$ ) and area under the curve (AUC) were calculated



# Results



# Glucose

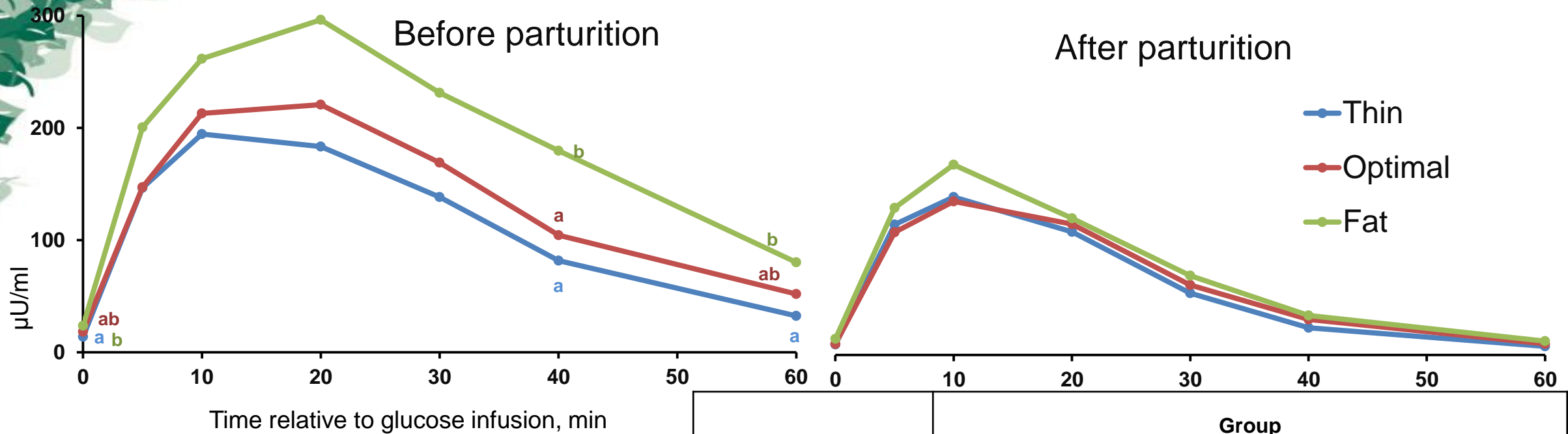


- Glucose peak was lower and clearance quicker after parturition compared to before parturition values
- Before parturition Fat group had higher increment and AUC 5-60 min compared to Thin group
- Overlapping curves after parturition

| Calculated Characteristic | Group              |              |              |                   |         |       |
|---------------------------|--------------------|--------------|--------------|-------------------|---------|-------|
|                           | Before parturition |              |              | After parturition |         |       |
|                           | Thin               | Optimal      | Fat          | Thin              | Optimal | Fat   |
| Increment, mg/dl          | <b>145.9</b>       | <b>154.7</b> | <b>160.2</b> | 119.0             | 117.7   | 125.7 |
| CR, %/min                 | -3.54              | -3.19        | -3.40        | -6.10             | -6.56   | -5.64 |
| T1/2, min                 | 20,9               | 23,5         | 21,9         | 12.3              | 12.6    | 14.0  |
| AUC 5-30, (mg/dl)*min     | 2141               | 2387         | 2540         | 1730              | 1766    | 1847  |
| AUC 5-60, (mg/dl)*min     | <b>3175</b>        | <b>3687</b>  | <b>3849</b>  | 2132              | 2164    | 2368  |

a, b, c – Different letters express significant difference between groups,  $p < 0.05$

# Insulin



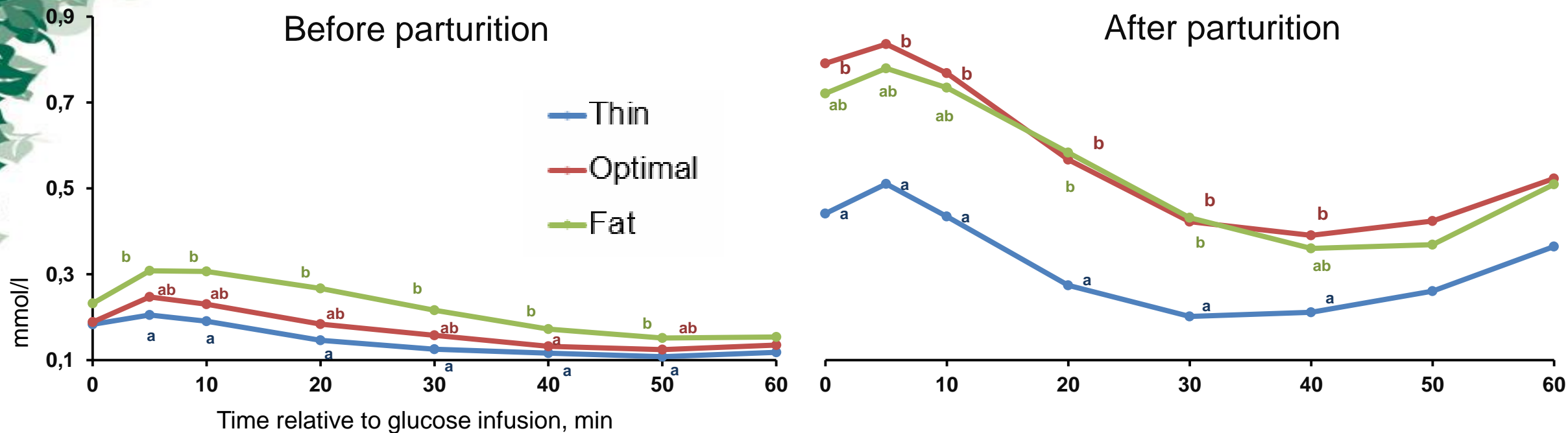
- Insulin peak was lower and clearance quicker after parturition compared to before parturition values
- Before parturition Fat group had higher response compared to Thin group
- Overlapping insulin curves after parturition

| Calculated Characteristic | Group              |             |              |                   |         |       |
|---------------------------|--------------------|-------------|--------------|-------------------|---------|-------|
|                           | Before parturition |             |              | After parturition |         |       |
|                           | Thin               | Optimal     | Fat          | Thin              | Optimal | Fat   |
| Increment, µU/ml          | 187.2              | 210.7       | 286.2        | 129.4             | 124.4   | 149.0 |
| CR, %/min                 | -3.01              | -2,46       | -1,18        | -6,12             | -5.05   | -5.55 |
| T1/2, min                 | 25.1               | 31.7        | 156.8        | 9.5               | 18.7    | 11.0  |
| AUC 5-30, (µU/ml)*min     | 4060               | 4701        | 6140         | 2470              | 2515    | 2784  |
| AUC 5-60, (µU/ml)*min     | <b>5863</b>        | <b>7060</b> | <b>10099</b> | 2869              | 3073    | 3296  |

a, b, c – Different letters express significant difference between groups,  $p < 0.05$



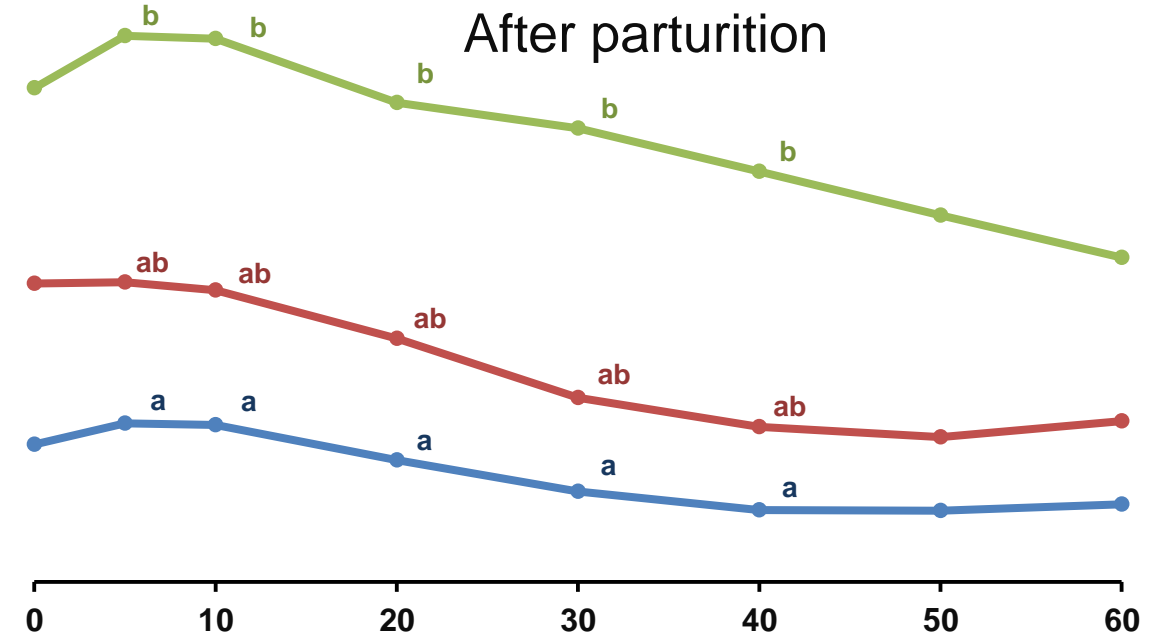
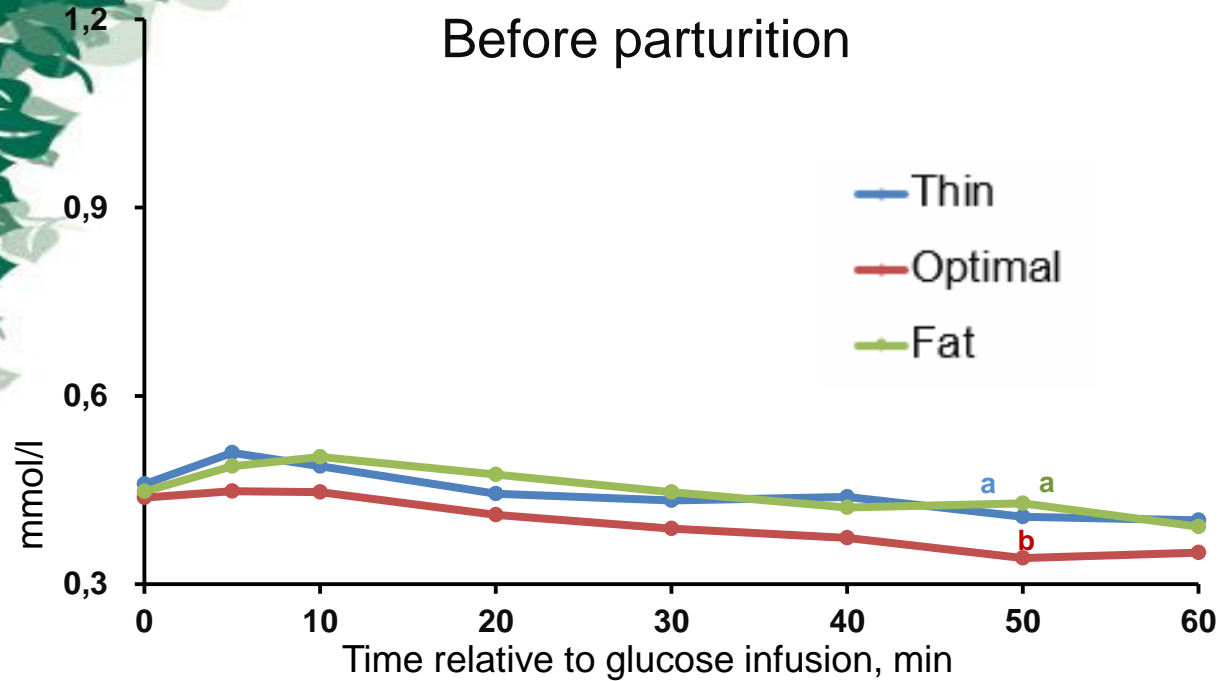
# Non-estrified fatty acids



- After parturition basal concentration was up to 4 times higher than before parturition, indicating increased lipolysis
- Before parturition there is no difference between groups in basal concentration, but different reaction to glucose infusion
- After parturition Fat and Optimal group had similar basal concentrations

a, b, c – Different letters express significant difference between groups,  $p < 0.05$

# B-hydroxybuturate



- Fat and Optimal group had a lot higher basal concentration after parturition, but no difference in Thin group
- Overlapping concentrations before parturition
- After parturition Fat group had higher BHB concentrations, although similar NEFA concentrations

a, b, c – Different letters express significant difference between groups,  $p < 0.05$

# Conclusions

- Metabolic status was different before and after parturition
- Before parturition higher insulin response in Fat cows did not bring along quicker glucose disappearance and reduction of NEFA, indicating adequate pancreatic response, but increased insulin resistance in peripheral tissues
- After parturition Fat group had similar NEFA, but numerically higher BHB concentration compared to Optimal group, indicating similar fat release, but not use

# Conclusions

- Small differences in glucose and insulin curves after parturition could be caused by high proportion of insulin independent glucose flow to the udder, overshadowing the possible differences of insulin dependent uptake
- BCS influences glucose and lipid metabolism before parturition; however, after parturition it may not play such a relevant role in glucose metabolism but may have more profound effect on lipid metabolism



# Thank you!

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