



# Development of genetic evaluations for metabolic disease traits for Canadian dairy cattle

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# Canadian health recording system

- Health recording system since April 2007
- Recording done by producers on a voluntary basis
- Eight diseases are recorded: mastitis, displaced abomasum, ketosis, milk fever, retained placenta, metritis, cystic ovaries and lameness
- Overall goal is to develop a **genetic evaluation for** resistance to **diseases** in Canadian dairy cattle

# Objective

Estimate genetic parameters for metabolic diseases (**ketosis, displaced abomasum, milk fever**) and their main predictors (**body condition score, fat to protein ratio, milk  $\beta$ -hydroxybutyrate**) in Canadian Holsteins

# Disease data

- **Data validation**

- Minimum disease frequency of 1% per herd and year

- **Trait definition**

- Binary traits, scored as 1 or 0, based on whether or not the cow had at least one disease case
  - within 100 days after calving for ketosis
  - within 100 days after calving for displaced abomasum
  - within 30 d after calving for milk fever

# Data

- **BCS** from routine type classification
- **F:P** from routine milk recording system
- **Milk BHBA**
  - Screening for hyperketonemia based on a milk BHBA analysis offered in Canada by Valacta (DHI organization responsible for Québec and Atlantic provinces) since October 2011
  - Test-day milk samples (5-100 DIM) are analyzed by a mid infrared spectrometer with previously developed calibration equations for milk BHBA from Foss

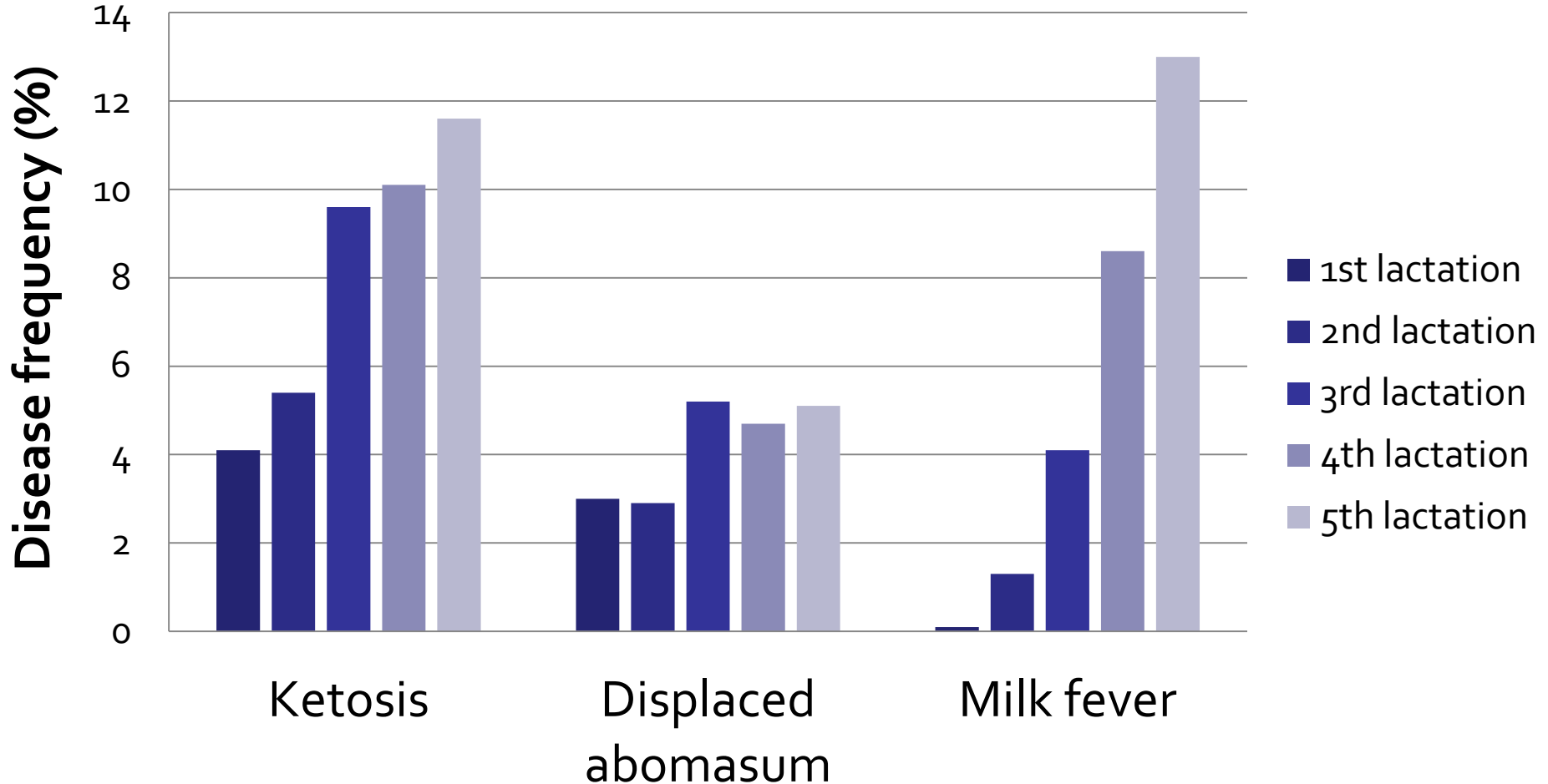
# Descriptive Statistics

Trait	No. Records	Mean (SD)
Ketosis, %	120,497	5.1
Displaced abomasum, %	296,539	3.3
Milk fever, %	207,903	1.2
BCS, score	230,222	2.82 (0.35)
F:P at the first test-day (5-40 DIM)	410,253	1.32 (0.27)
BHBA at the first test-day (5-40 DIM), mmol/L <sup>1</sup>	55,623	0.106 (0.081)

<sup>1</sup>For genetic analyses BHBA was transformed as follows:  $\log_e(\text{BHBA}+1)$

# Summary of analyzed data

## Disease frequencies by parity



# Model – Disease traits, F:P, milk BHBA

**First and later lactation** traits were treated as **different traits**. The model for **first lactation traits** was as follows:

$$\mathbf{y} = \mathbf{X}\boldsymbol{\beta} + \mathbf{Z}_s\mathbf{s} + \mathbf{e}$$

- $\mathbf{y}$  = vector of observations
- $\boldsymbol{\beta}$  = vector of systematic effects, including fixed effects of age at calving, year-season of calving and herd-year of calving for all traits and days in milk for F:P and milk BHBA
- $\mathbf{s}$  = vector of random additive genetic sire effects
- $\mathbf{e}$  = vector of random residuals
- $\mathbf{X}$ , and  $\mathbf{Z}_s$  are incidence matrices

For **later lactation traits** a fixed effect of lactation (2, 3, 4, 5) was fitted (instead of age at calving) and the permanent environmental effect was included.



# Model – BCS

$$\mathbf{y} = \mathbf{X}\boldsymbol{\beta} + \mathbf{Z}_s\mathbf{s} + \mathbf{e}$$

- $\mathbf{y}$  = vector of observations
- $\boldsymbol{\beta}$  = vector of systematic effects, including fixed effects of age at calving-stage of lactation and herd-round-classifier of calving
- $\mathbf{s}$  = vector of random additive genetic sire effects
- $\mathbf{e}$  = vector of random residuals
- $\mathbf{X}$ , and  $\mathbf{Z}_s$  are incidence matrices

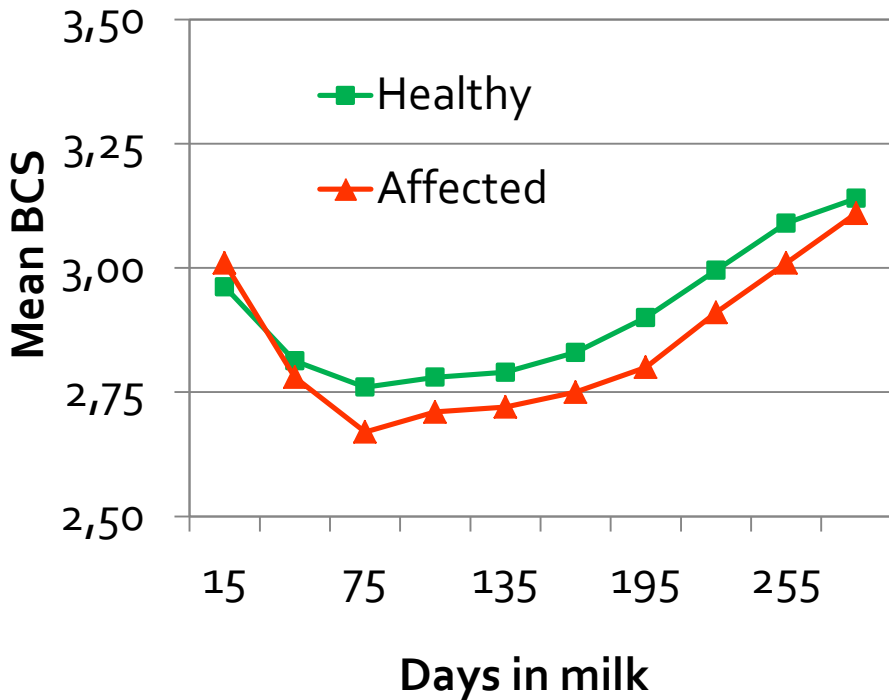
# Analyses

- Uni- and multivariate linear sire models
- DMU package (Madsen and Jensen, 2008)

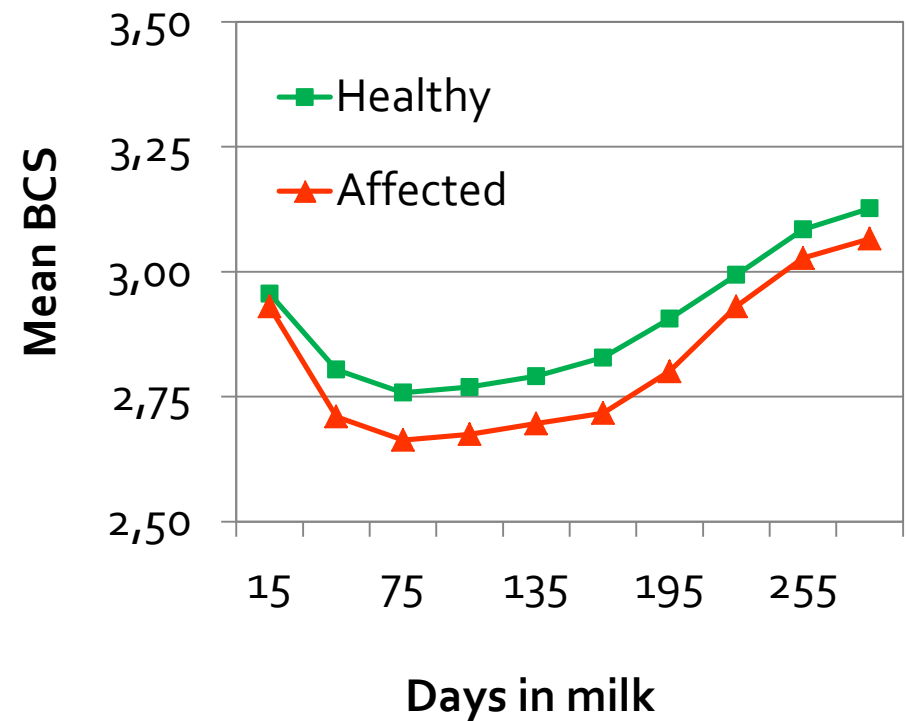
# Phenotypic associations

## Disease and BCS – First lactation

### Ketosis and BCS



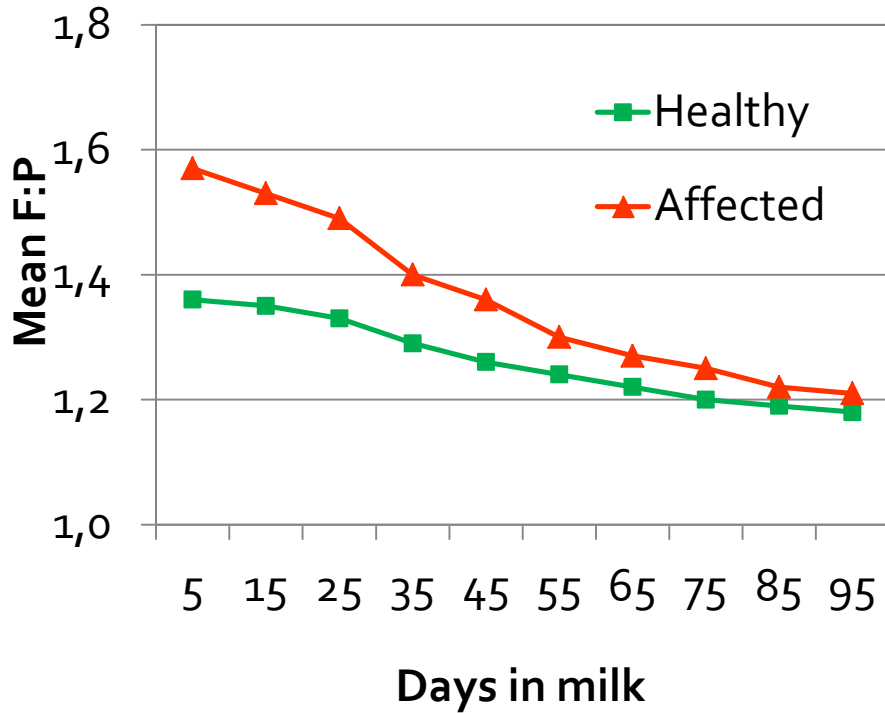
### Displaced abomasum and BCS



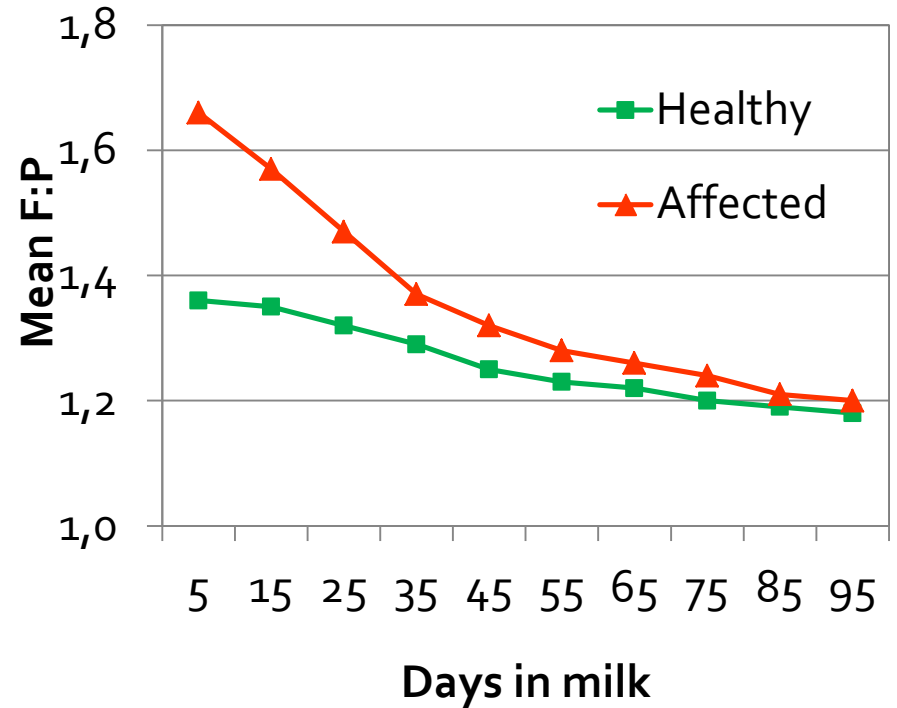
# Phenotypic associations

## Disease and F:P – First lactation

### Ketosis and F:P



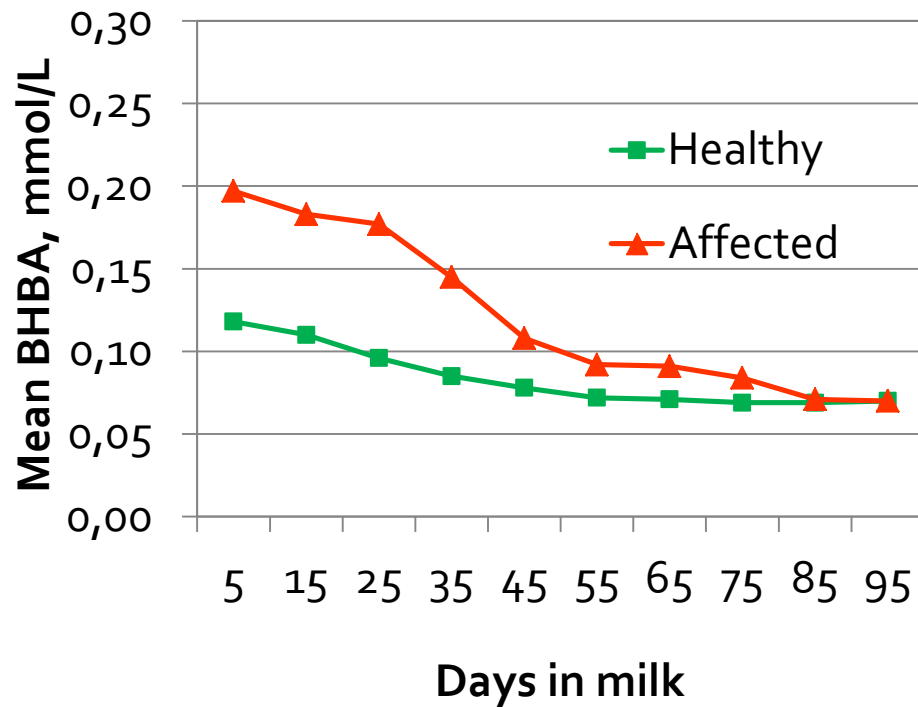
### Displaced abomasum and F:P



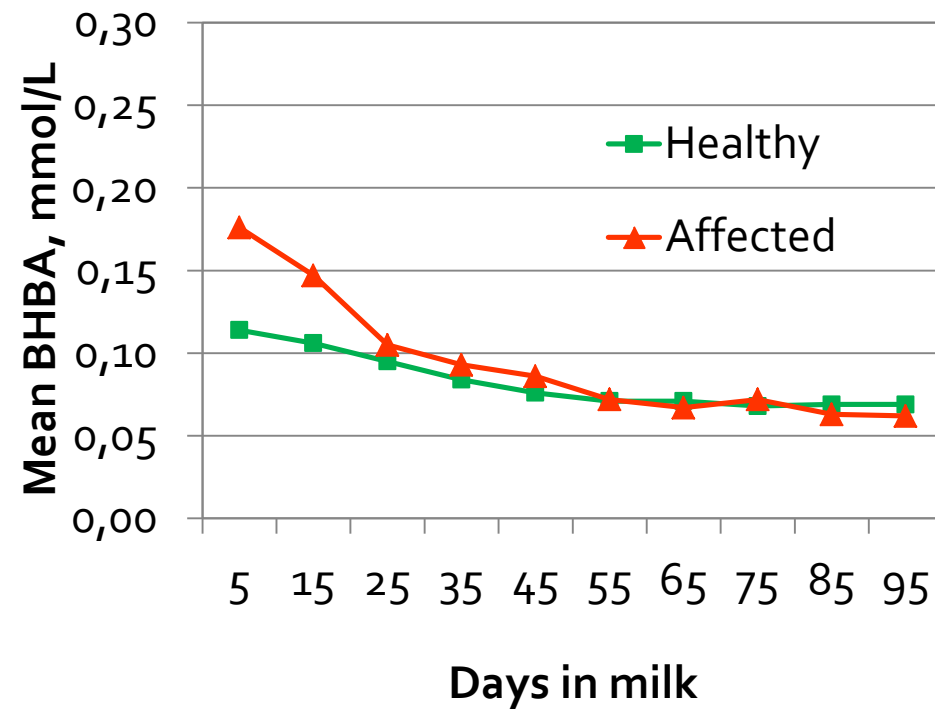
# Phenotypic associations

## Disease and BHBA – First lactation

### Ketosis and BHBA



### Displaced abomasum and BHBA

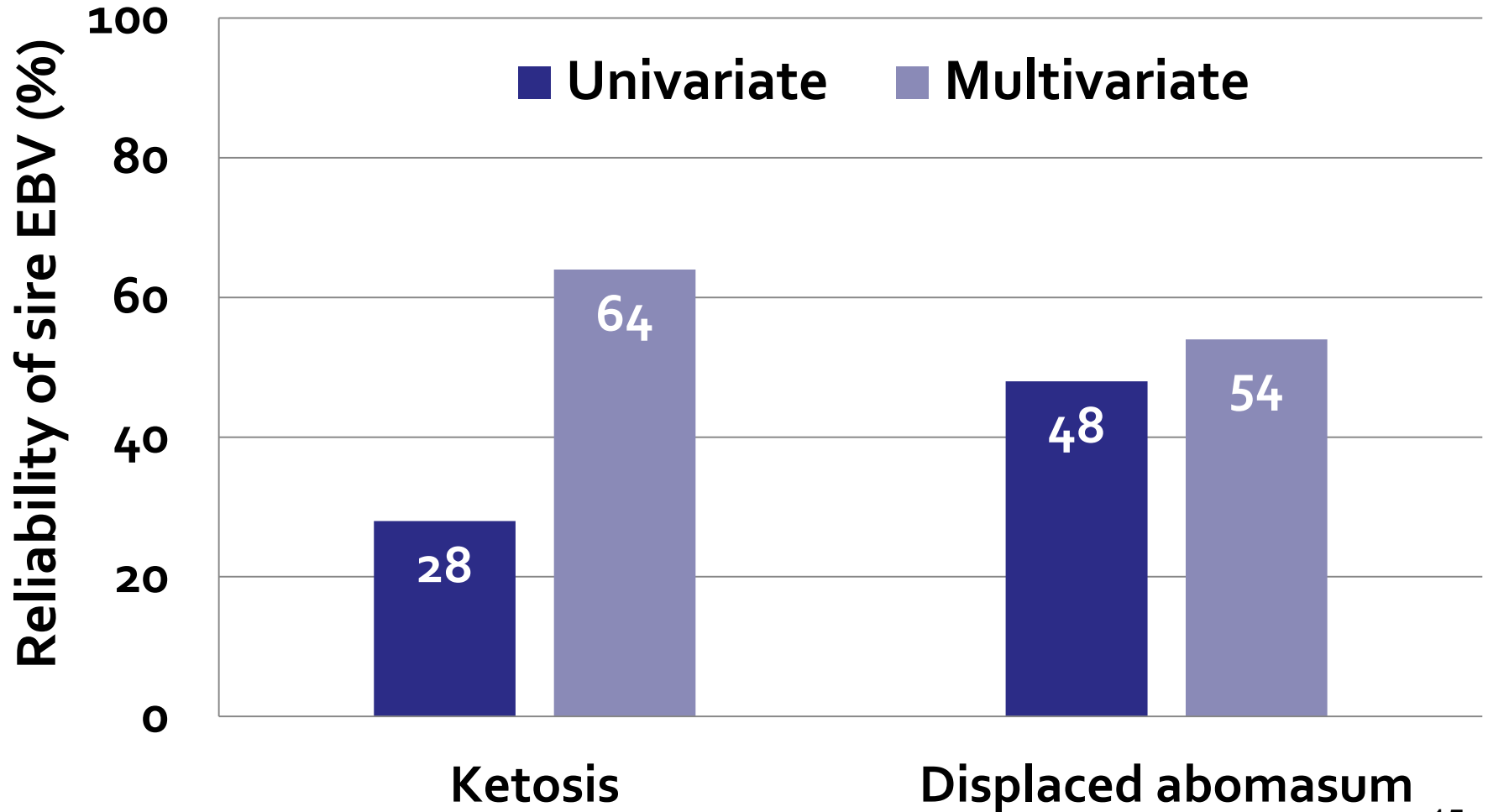


# Genetic parameters – First lactation

Trait	KET	DA	BCS	F:P	BHBA
Ketosis (KET)	0.02	0.76	-0.54	0.37	0.75
Displaced abomasum (DA)		0.05	-0.40	0.19	0.15
BCS			0.22	-0.30	-0.43
F:P				0.16	0.32
BHBA					0.10

# EBV Reliability – First lactation

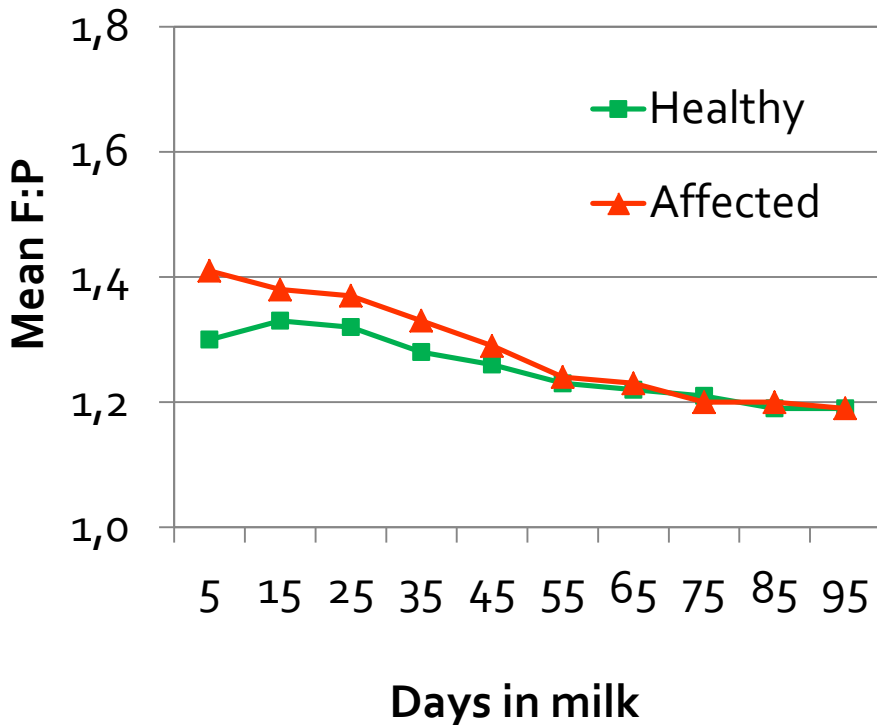
## Sires with 51-100 daughters



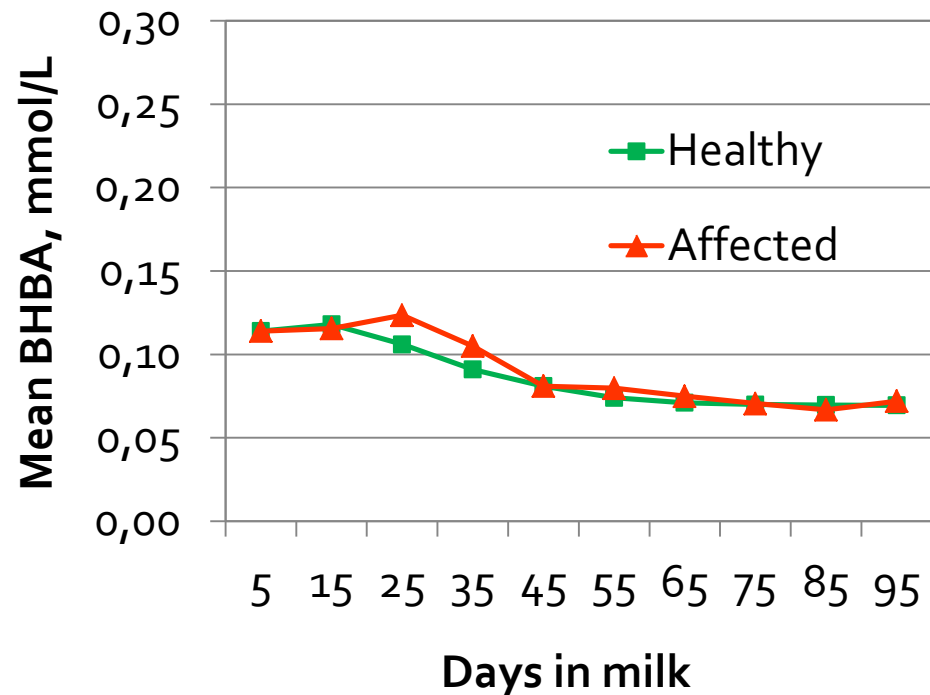
# Phenotypic associations – Later parities

Similar phenotypic associations between ketosis/displaced abomasum and F:P and BHBA as in first lactation cows

### Milk fever and F:P



### Milk fever and BHBA





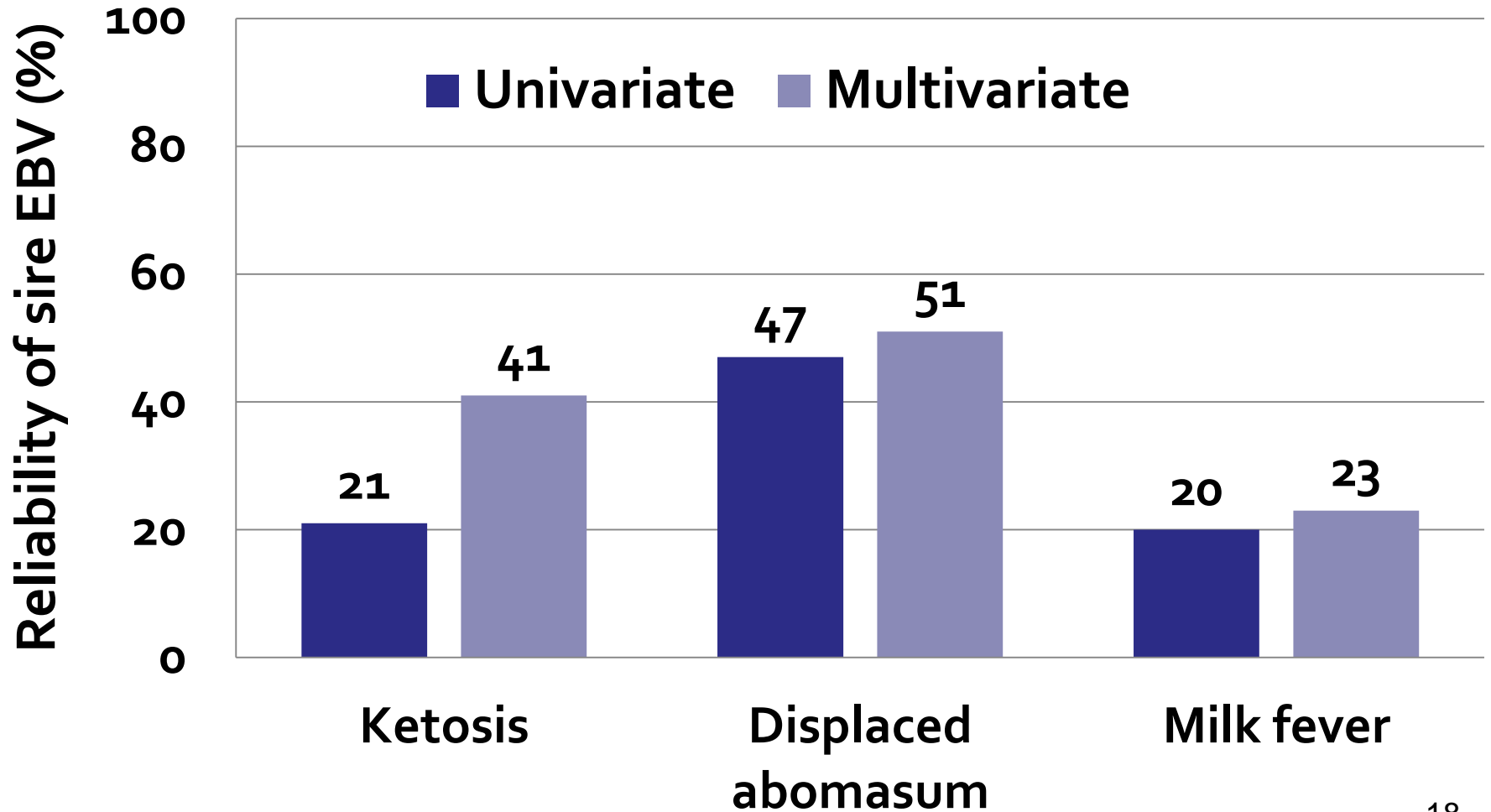
# Genetic parameters – Later lactations

Trait	KET	DA	MF	F:P	BHBA
Ketosis (KET)	<b>0.03</b>	0.54	0.39	0.57	0.75
Displaced abomasum (DA)		<b>0.02</b>	0.15	0.24	-0.03
Milk fever (MF)			<b>0.01</b>	-0.02	0.33
F:P				<b>0.12</b>	0.25
BHBA					<b>0.11</b>

Trait	Genetic correlation
KET <sub>1</sub> and KET <sub>2-5</sub>	0.79
DA <sub>1</sub> and DA <sub>2-5</sub>	0.86

# Reliability – Later lactations

## Sires with 51-100 daughters



# Next steps

- Ketosis strongly correlated with milk BHBA  
→ accumulate more BHBA records
- Milk fever will not be included in routine genetic evaluation (low reliability)
- 9 trait model:

<i>First parity</i>	<i>Later parities</i>
<i>Ketosis</i>	<i>Ketosis</i>
<i>DA</i>	<i>DA</i>
<i>BCS</i>	
<i>BHBA</i>	<i>BHBA</i>
<i>F:P</i>	<i>F:P</i>



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Dairy Farmers  
of Canada



Les Producteurs laitiers  
du Canada



Ontario **Genomics** Institute



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Agroalimentaire Canada



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