中国農業大學
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Genetic analysis of skinfold thickness and its association with body condition score, and milk production traits in Chinese Holstein population

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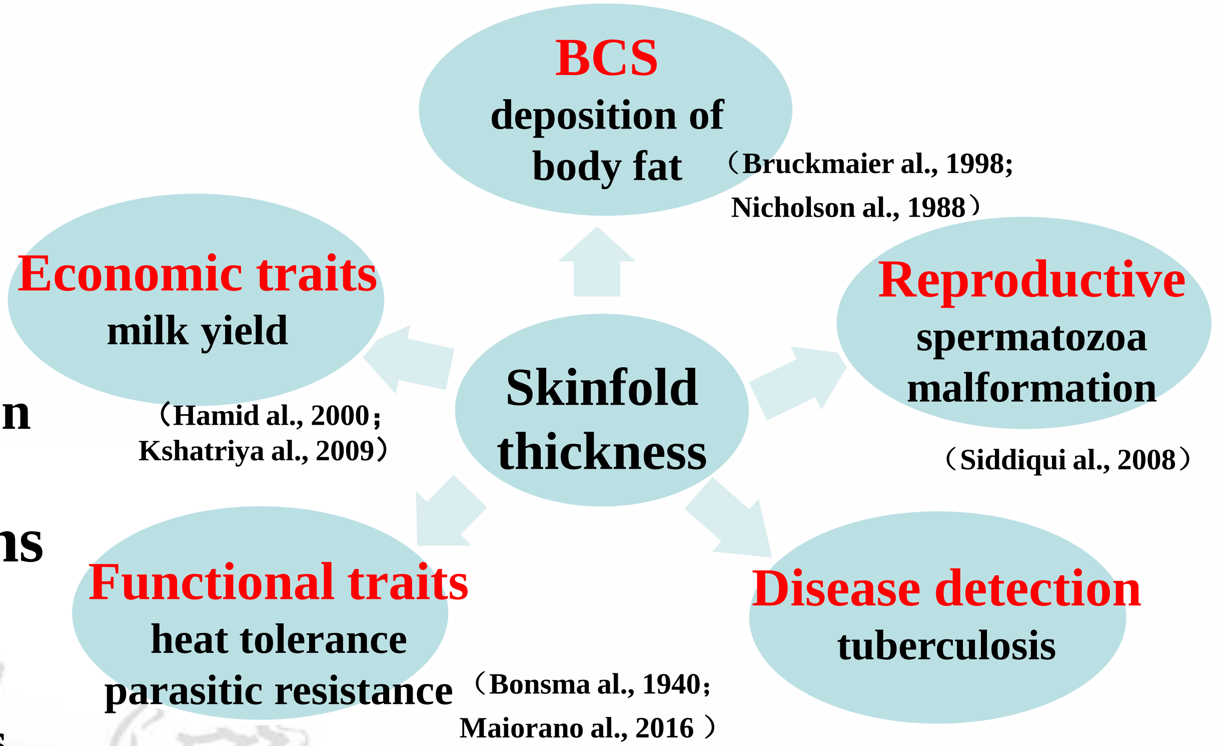
Background

- Skin: the outermost structure and the **largest organ** of the mammals' body, undertakes the many important functions

- Skinfold thickness:
  - ✓ widely used to represent **skin thickness**
  - ✓ measuring method **friendly** to animal
  - ✓ suitable for measurement in large population

- The **neck and rib** are the body regions frequently used in previous studies
  - ✓ different repeatability in different regions
  - ✓ different measuring difficulty in different regions



Background

- In previous studies, the factors affecting the skinfold thickness have been explored (Dowling al., 1955; Patel al., 1958; Hayman al., 1966)
  - ✓ breed, body regions, nutrition status, gender, age and measurer
- Skinfold thickness is an important trait, however not been considered seriously in dairy. Very little studies regarding genetic analysis of skinfold thickness

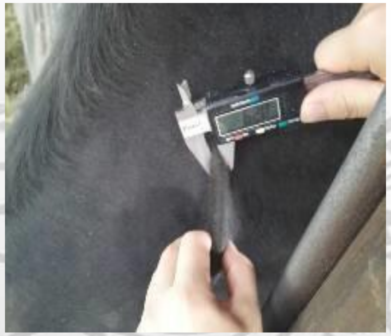
year	author	species	Body region	No. Obs	h^2
2016	Maiorano	Nellore	scapula	17940	0.12 ± 0.02
1991	Slee	Merino Sheep	right mid-side	-	0.35±0.19

- The objectives of this study were to estimate the heritability of skinfold thickness and its genetic association with BCS and milk production traits in Chinese Holstein

Material & method

- Holstein milking cows in 9 scaled farms in Beijing
- Measurement: skinfold thickness, BCS
  - ✓ skinfold thickness at the neck (STN)
  - ✓ skinfold thickness at the last rib (STR)
- Device: Digital Vernier caliper
- Collecting test-day records during measuring period

Year-month	No. of farms
2015, July-Aug	6
2016, June-Aug	7



Measuring skinfold thickness at the neck

Measuring skinfold thickness at the last rib

Body condition score (BCS)

Material & method

- Factor analysis (SAS, GLM)

$$STN_{ijkl} = \mu + FM_i + PARITY_j + STAGE_k + b_1 BCS + e_{ijkl}$$

$$STR_{ijklm} = \mu + FM_i + PARITY_j + STAGE_k + BODYSIDE_l + b_2 BCS + e_{ijklm}$$

- Genetic analysis (DMU, animal model)

- bi-variate: STN, STR
- 6-traits: STN, STR, BCS, MY, FP and PP

$$STN = FM + PARITY + STAGE + A + E$$

$$STR = FM + PARITY + STAGE + BODYSIDE + A + E$$

$$BCS = FR + STAGE + A + E$$

$$MY = FY + PARITY + STAGE + A + E$$

$$FP = FY + PARITY + STAGE + A + E$$

$$PP = FY + PARITY + STAGE + A + E$$

- *Traits*

STN: skinfold thickness over the neck
STR: skinfold thickness over the last rib
BCS: body condition score *MY*: milk yield
FP: milk fat percentage *PP*: milk protein percentage

- *Effects*

FM: farm-measurer of skinfold
FR: farm-rater of BCS
FY: farm-year of test-day records
PARITY: parity of the cow
STAGE: milking stage of the cow
BODYSIDE: body side of the measured cow
b_1/b_2: regression coefficient for *BCS*
A: random additive genetic effect
E: random residual effect

Results & discussion

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➢ Descriptive statistics

Traits	No. Obs	MAX	MIN	MEAN	SD	CV
STN/mm	4428	1.00	13.28	7.16	1.30	18.1%
STR/mm	4452	1.07	22.77	11.76	1.97	16.7%
BCS	5810	1.00	5.00	2.90	0.79	27.4%
MY/kg	5646	0.80	90.00	34.58	10.20	29.5%
FP/%	4980	0.68	7.99	3.97	0.88	22.2%
PP/%	5544	1.53	9.33	3.01	0.30	10.1%

- The STN was thinner than STR
- There is a significant body side effect on skin thickness at the last rib!

➢ Factor analysis

Traits	R^2	FM/FS/FY		Stage		Parity		BCS		Body side	
		df	F-value	df	F-value	df	F-value	df	F-value	df	F-value
STN	0.39	13	205.41**	5	6.23**	4	19.49**	1	60.76**		
STR	0.37	12	109.56**	5	3.18**	4	27.78**	1	71.53**	1	149.69**

Results & discussion

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➢Results from bi-variate model

Traits	No. Obs	Additive VC	Error VC	Phenotype VC	Heritability ±SE
STN	4307	0.13	0.90	1.03	0.13±0.03
STR	4331	0.63	1.97	2.60	0.24±0.04

➢Results from 6-traits model

Traits	No. Obs	Additive VC	Error VC	Phenotype VC	Heritability ±SE
STN	4307	0.13	0.90	1.03	0.13±0.03
STR	4331	0.64	1.96	2.61	0.25±0.05
BCS	5585	0.05	0.34	0.39	0.12±0.03
MY	5634	8.34	68.73	77.07	0.11±0.02
FP	4969	0.05	0.66	0.71	0.07±0.02
PP	5533	0.01	0.07	0.08	0.08±0.02

- ✓ Estimated heritabilities for STN was higher than STR: low to moderate
- ✓ Estimated heritability of STN & STR are similar between bi-variate model and 6 traits model
- ✓ The estimated heritability was similar with the previous study on Nellore (Maiorano al., 2016)

Results & discussion

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➢Results from 6-traits model

Genetic (below the diagonal) and phenotypic (above the diagonal) correlations

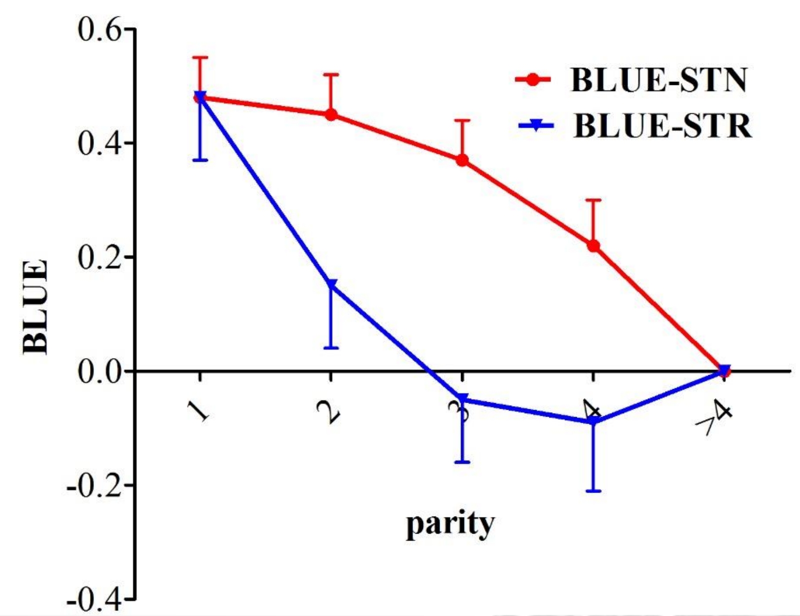
Traits	STN	STR	BCS	MY	FP	PP
STN		0.33	0.13	-0.01	0.00	-0.01
STR	0.80±0.08		0.15	-0.05	-0.02	-0.02
BCS	0.34±0.15	0.19±0.14		-0.21	0.03	0.09
MY	0.13±0.16	-0.03±0.15	-0.35±0.14		-0.08	-0.16
FP	0.13±0.20	0.04±0.18	0.17±0.19	-0.69±0.15		0.28
PP	0.05±0.19	0.04±0.17	0.30±0.12	-0.58±0.15	0.66±0.17	

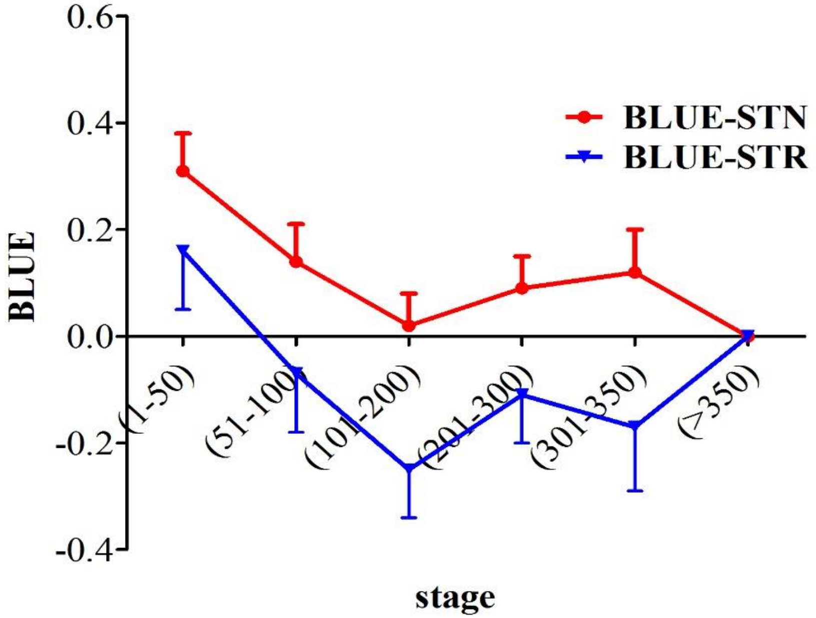
- ✓ a high genetic correlation existed between STN and STR
- ✓ a moderate and positive genetic correlation between STN and BCS (0.34)
- ✓ Low genetic correlations existed between skinfold thickness and milk performance. r_g of STN and milk production traits were higher than that between STR and milk production traits

Results & discussion

➢BLUE of fixed effects

BLUE：best linear unbiased estimated





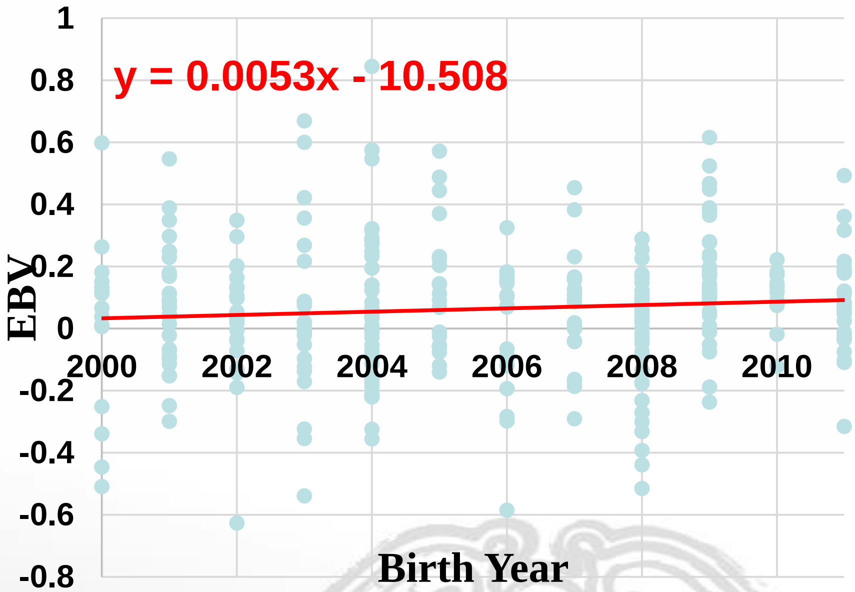
Body side	STR	
	N	BLUE±SE
Left	860	-0.83±0.11
Right	3074	0.00±0.00

- ✓ **Roughly, skinfold thickness decreased with the increase of parity, first drop and then rise with the increase of DIM**
- ✓ **Skinfold thickness is sensitive to change of parity and milking stage in lactating cows**

Results & discussion

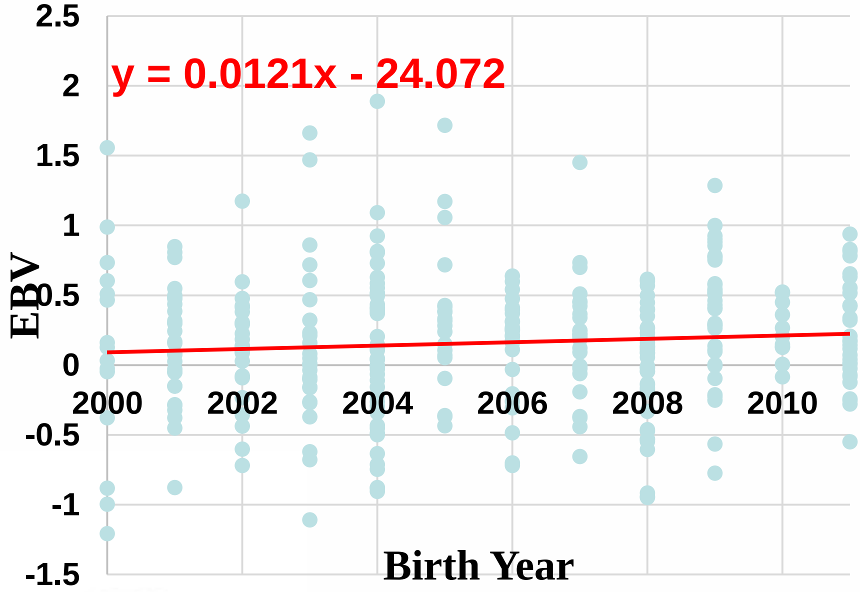
- genetic trend of EBV of skinfold thickness (bulls with Rel. >0.1)

STN



reliability>0.1， N=309

STR



reliability>0.1， N=329

From 2000 to 2011

Change of EBV=0.06 mm=0.17σ_A

Change of EBV=0.14 mm=0.18σ_A

Conclusions

- Skinfold thickness is a trait with a low to moderate heritability, and there is a high genetic correlation between skinfold thicknesses on different body regions in Holstein population
- Skinfold thickness is easy measurable trait and sensitive to change of parity and milking stage in lactating cows
- Skinfold thickness can be considered as an additional information of BCS to evaluate fat deposition
- Selection on skinfold thickness to improve milking cow's ability to fight with the negative energy balance is feasible as only weak genetic correlations existed between skinfold thickness and milk performance

Acknowledgement

Thanks for listening ☺

Open for questions ☺

Discussions

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➢ Genetic correlations with other traits

	Rectal temperature (AM)	Rectal temperature (PM)	longevity	Healthy traits (reproduction)	Healthy traits (digestion)	Healthy traits (udder)	Healthy traits (hoofs)
STN	-0.14	-0.02	0.13	-0.14	0.01	0.03	0.06
STR	-0.11	-0.09	0.20	-0.11	0.00	-0.01	-0.02

$$\hat{r}_{g_{i,j}} = \frac{\sqrt{(\sum RL_i) \times (\sum RL_j)}}{\sum (RL_i \times RL_j)} \times r_{i,j}$$

$$SE = \sqrt{\frac{1 - \hat{r}_{g_{i,j}}}{n-2}}$$

(Hickman et al., 1969; Calo et al., 1973)