EFFECT OF BODY CONDITION SCORE AT PARTURITION ON THE PRODUCTION PERFORMANCE, FERTILITY AND CULLING IN PRIMIPAROUS ESTONIAN HOLSTEIN COWS

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Summary. The objective of this study was to estimate the relation of body condition score (BCS) near calving to the body condition change in early lactation, the reproductive performance, milk yield and culling rate in the first lactation Estonian Holstein dairy cows. Cows were divided into three groups based on their BCS at calving; thin, BCS ≤3.0 (n=29); moderate, BCS 3.25–3.5 (n= 48); and fat, BCS ≥3.75 (n=27). During the first and second month of lactation the fat cow group had significantly higher ($P<0.05$) fat corrected milk (FCM) production, milk fat percentage, and milk fat to protein ratio compared to thin cows. Thin cow group had significantly ($P<0.05$) higher genetic merit index (GMI) compared to the moderate and fat group, but they could not realise their genetic potential as the 305-day fat corrected milk production, fat production, and milk fat + protein production was significantly higher ($P<0.01$) in fat cows compared to thin cow group. No cows in the fat group conceived from the first service. In the thin group 14%, in the moderate group 25% and in the fat group 41% cows were culled during the first lactation respectively. We concluded that while taking into account besides milk production the aspects of health and fertility, the reasonable BCS at calving of first lactation Estonian Holstein cows in the present management and feeding conditions was 3.25–3.5 BC units.

Key words: body condition score, milk yield, fertility, primiparous Estonian Holstein cows.

PIRMAVERŠIŲ ESTIJOS HOLŠTEINŲ ORGANIZMO BŪKLĖS VERŠIAVIMOSI METU ĮTAKA PRODUKCIJAI, VAISINGUMUI IR BROKAVIMUI

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Santrauka. Šio tyrimo tikslas buvo nustatyti bendros organizmo būklės (BOB) pobūdį prieš veršiavimąsi ir ankstyvos laktacijos laikotarpiu, reprodukcijos galimybes, pieno produkciją ir brokavimo lygį Estijos holšteinų pirmaveršių organizme. Karvės buvo suskirstytos į tris grupes pagal BOB veršiavimosi metu: liesos – BOB ≤3,0 (n=29), vidutinio riebumo – BOB 3,25–3,5 (n= 48), ir riebios – BOB ≥3,75 (n=27). Pirmąjį ir antrąjį laktacijos mėnesį riebių karvių grupėje buvo nustatytas patikimai didesnis pieno riebalų kiekis ir pieno riebalų bei proteinų santykis palyginti su liesomis karvėmis ($p<0,05$). Liesų karvių grupei buvo būdingas aukštesnis genetinių savybių indeksas ($p<0.05$) negu vidutinio riebumo ir riebių karvių grupių, bet jos negalėjo panaudoti savo genetinių galimybių, mat po 305 dienų pieno produkcijos riebalų korekcijos koeficientas, riebalų kiekis ir pieno riebalų + baltymų kiekis buvo didesnis riebių karvių organizme ($p<0,01$). Nė viena karvė riebių karvių grupėje netapo veršinga pirmo apsėklinimo metu. 14 proc. liesų karvių, 25 proc. vidutinio riebumo ir 41 proc. riebių karvių buvo brokuotos jau pirmosios laktacijos metu. Galima teigti, kad, įvertinant ne tik pieno produkciją, bet sveikatos būklę bei vaisingumą, reikiamas kūno svorio indeksas Estijos Holšteino veislės karvių veršiavimosi ir pirmosios laktacijos metu, esant dabartinėms šėrimo sąlygoms, yra 3,25–3,5 BOB vienetų.

Raktažodžiai: organizmo būklės indeksas, pieno produkcija, vaisingumas, pirmaveršės Estijos Holšteino veislės karvės.

Introduction. Estonian dairy farming has changed a lot over the last decade; the number of cows and farms has decreased, the yearly milk production per cow has improved, cows are fed total mixed rations (TMR), and new free stall barns have replaced old type buildings. Average annual milk yield per cow has increased from 4232 kg in 1990 to 6509 kg in 2005. Semen is imported from different countries and Holstein cow population has replaced Estonian Red cows to a great extent. However, several problems have arisen with these changes - average days open has increased from 108 in 1995 to 136 in 2005, the proportion of cows culled for udder and feet disorders has grown, the average number of lactations per cow has decreased to 3.6 (Results of Animal Recording in Estonia, 2005). Therefore farmers are more motivated to focus on management and feeding practices enabling them to overcome the problems. New strategies are especially important during the early lactation period when dietary intake is unable to meet the demands of high milk production. Cows mobilize body tissue energy and lose body weight to balance the deficit between food energy intake and milk energy output (Bauman and Currie, 1980). This leads to a negative energy balance (NEB), which may last from 40 to 60 days postpartum (Sutter and

Beever, 2000) or even longer (De Vries and Veerkamp, 2000).

Body condition scoring (BCS) is an easy and reliable method to estimate the nutritional status and the efficiency of a feeding system for dairy cows. Dairymen and their advisors can use changes in BCS to assess the level and change of body fat stores as an indicator of energy balance and metabolic load (Edmonson et al., 1989; Fergusson et al., 1994). Moreover, research has shown that BCS has value as a potential selection tool for improving fertility (Pryce et al., 2001). Several studies reveal that BCS at calving and body condition loss in early lactation are related to health, fertility and milk yield (Gearhart, 1990; Pedron et al., 1993; Markusfeld et al., 1997; Domecq et al., 1997). Regular body condition scoring has been used in dairy cattle management in several countries for a long time. In Estonia, however, it is a relatively new method and has been used mostly for research purposes so far. Therefore the objective of this study was to estimate the relation of BCS near calving to the body condition change in early lactation, the reproductive performance, milk yield and culling rate in the first lactation Estonian Holstein dairy cows.

Materials and Methods.

Cows and housing

The study was carried out on an experimental dairy farm of about 90 cows of three different breeds during the years from 2000 to 2005. One hundred and four first lactation Estonian Holstein dairy cows were involved in the final data analysis. The cows were kept in a tie-stall barn, milked three times a day and the average milk yield of the farm was 8821 kg. Heifers were brought into the barn and entered the study about two weeks before expected calving. Cows were fed TMR *ad libitum* twice a day, at 9.00 and 16.00. The TMR that the heifers were fed from the 10th day before the expected calving till the 150th day of lactation contained 12.0 MJ metabolizable energy (ME) and 105g of metabolizable protein (MP) in one kg dry matter (DM), the crude fiber and acid detergent fiber (ADF) percentages were at least 13% of and 18%, respectively. The cows more than 150 days in milk were fed lower energy density TMR that contained 11.0 MJ ME, 95g MP, at least 15% crude fiber and 23% ADF in one kg DM. During the summer period cows were taken out to pasture for four hours a day. Rations consisted of haylage, corn meal, heat-treated rapeseed cake and barley meal and were supplemented with minerals, except 10 days before till two weeks after calving while cows were fed minerals manually. The cows were weighed on a scale once a month; milk recording was carried out bimonthly, and milk analyses to determine milk fat and protein content were performed in the milk laboratory of the Estonian Animal Recording Centre using an analyzer *System 4000*. The herd veterinarian recorded all diseases and culling reasons.

Body condition scoring

During the five-year study the same observer performed body condition scoring fortnightly using the technique developed by Edmonson et al. (1989). The cows were scored on a five-point scale with quarter point divisions, where score 1 was given to emaciated, score 3 to moderate and score 5 to obese cows. BCS was assessed based on the appearance of tissue cover over the bony prominences in the back and pelvic regions via palpation and visual inspection; the scorer had no knowledge of the previous BCS of the cow.

Analysis of data

For statistical analysis the cows were divided into three groups based on their BCS at calving; *thin*, BCS ≤3.0, *moderate,* BCS 3.25–3.5, and *fat*, BCS ≥3.75. The BCS and body weight at calving were defined as the closest measurement in relation to calving, but not more than ten days after parturition. Fat corrected milk (FCM) was calculated according to the formula: FCM=0.4 x milk kg + 15 x milk fat kg. The SAS procedure GLM and the Bonferroni method were used for the multiple comparisons of the average values of studied traits in different BCS groups. The results are presented as arithmetical means and standard errors (S.E.). Statistical significance was declared at $P<0.05$.

Results. The total number of cows entered the study was 104, out of them 29 cows (28%) were classified as *thin*, 48 cows (46%) *moderate*, and 27 cows (26%) *fat* at parturition. The mean age of all cows at calving was 26.3 ± 0.25 months. Average genetic merit index (GMI) of all cows investigated was 94; *thin* group had GMI 98 that was significantly ($P<0.05$) higher compared to the *moderate* and *fat* group GMI 93. Cows' weight near calving averaged 553 ± 6.3kg. *Fat* cow group was the heaviest, 576 ± 7.1 kg (n=21), and differed significantly ($P<0.05$) from the *moderate* group, 542 ± 9.1 kg (n=26), and *thin* group, 547 ± 9.7 (n=15).

Mean BCS at calving and the dynamics of BCS of the three different groups investigated are presented in Figure.1. BCS at parturition differed significantly among all three groups of cows ($P<0.001$). Cows of the *thin* group had BCS 2.85 ± 0.068, *moderate* group 3.36 ± 0.025 and *fat* cows 3.91 ± 0.055 at calving, respectively. During the first 30 days after calving cows lost on an average 0.49 ± 0.557 BCS units. *Thin* cows lost 0.25 ± 0.06, *moderate* cows 0.48 ± 0.043 and *fat* ones 0.60 ± 0.062 BCS units ($P<0.05$ between *moderate* and *fat* groups; $P<0.01$ between groups *thin* and *moderate,* and *thin* and *fat*). The time from calving to the lowest BCS point (nadir) was significantly shorter ($P<0.01$) in *thin* cows compared to the *fat* cows, 37 ± 2.2 and 53 ± 4.1 days, respectively. For the cows of the *moderate* group the length of this period was 49 ± 3.4 days. On the whole, during the period from calving to nadir the cows of the *thin* group lost 0.41 ± 0.057, *moderate* group 0.76 ± 0.042 and *fat* group 1.05 ± 0.049 BCS units ($P<0.001$), respectively.

Average 305-day milk production of all the cows investigated was 8836 ± 147.1 kg and FCM production 8353 ± 137.3 kg. Milk fat and protein production was 321 ± 5.8, and 282 ± 4.8 kg, respectively. Milk fat percentage was 3.64 ± 0.051 and protein percentage 3.35 ± 0.024. During the first and second month of lactation the *fat* cow group had significantly higher ($P<0.05$) FCM production and milk fat percentage (data not shown), and milk fat to protein ratio (Figure.2). Data of the 305-day milk production are presented in Table1. The FCM production, fat production, and milk fat + protein production differed significantly between groups *thin* and *fat* (P<0.01) and *thin* and *moderate* (P<0.05).

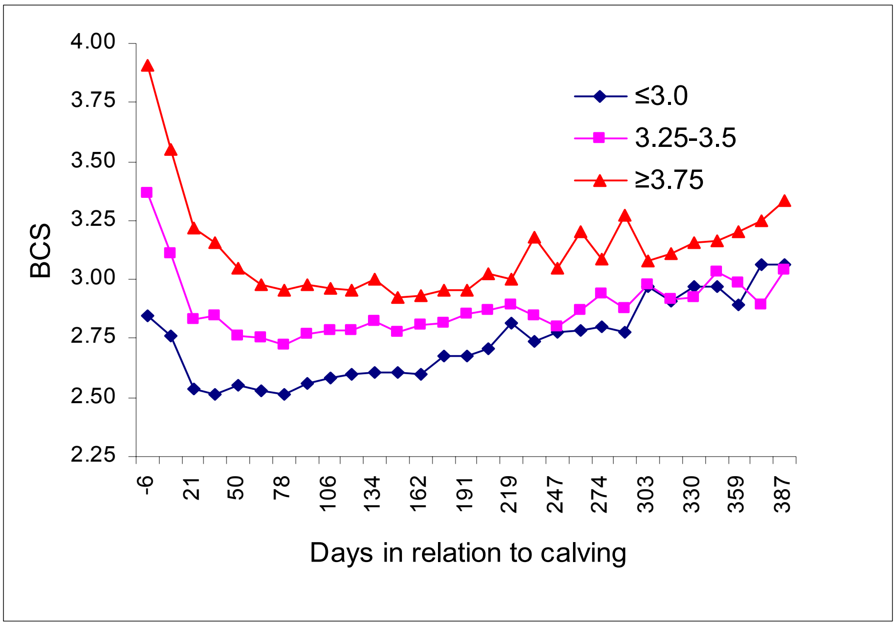

Figure 1 **Body condition score (BCS) dynamics relative to calving of the first parity Estonian Holstein cows grouped by BCS at parturition**

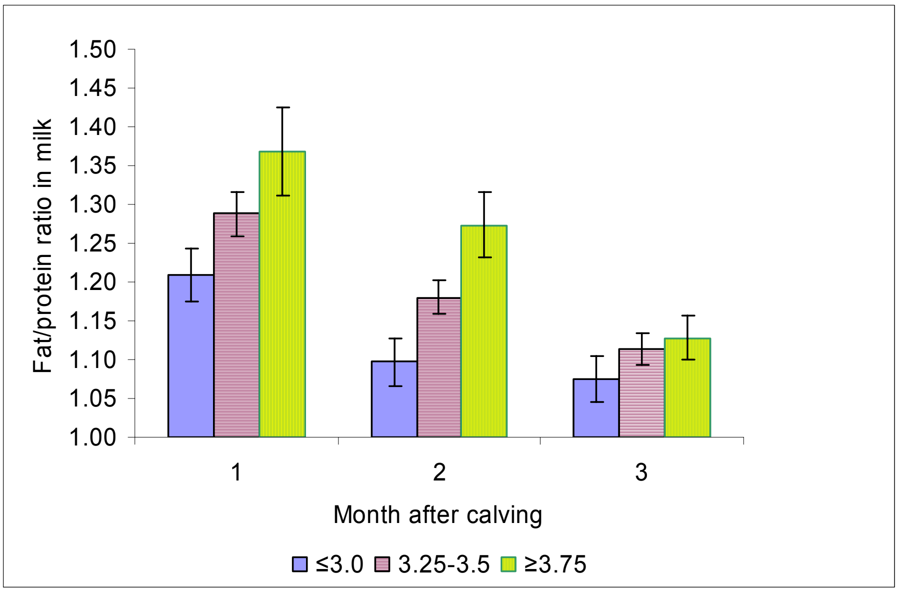

Figure 2 **Milk fat/protein ratio of the first lactation Estonian Holstein cows during the first 3 months after calving.** Values are means ± S.E. Milk fat/protein ratio was different (*P*<0.05) between BCS ≤3.0 (*thin*) and ≥3.75 (*fat*) groups during the first and second months of lactation

Fertility data of the three BCS cow categories are presented in Table 2. No cows in the *fat* group conceived from the first service. Other fertility parameters are not significantly different among the three groups investigated (P>0.05). Data of the culling rate and reasons are presented in Table 3. During the first lactation 27 cows out of 104 (26%) were culled, among them 8 cows were culled during the first 60 days of lactation. The percentage of cows culled in the *thin* group was 14%, in the *moderate* group 25% and in the *fat* cow group 41%, respectively.

Table 1. **305-day milk yield and components of the first parity Estonian Holstein cows grouped by BCS at parturition**

Production characteristics	Body condition score at calving		
	≤3.0 (n = 26)	3.25 – 3.5 (n = 40)	≥3.75 (n = 19)
Milk (kg)	8323 ± 201[a]	8718 ± 252[b]	9059 ± 258
FCM (kg)	7759 ± 184[c]	8283 ± 225[d]	8757 ± 257[d]
Fat (%)	3.57 ± 0.092	3.69 ± 0.062	3.79 ± 0.097
Protein (%)	3.40 ± 0.034	3.3 ± 0.032	3.38 ± 0.035
Fat (kg)	295 ± 8.5[ac]	320 ± 9.0[b]	342 ± 11.7[d]
Protein (kg)	282 ± 6.5[a]	287 ± 8.1	306 ± 9.2[b]
Fat and Protein (kg)	578 ± 13.4[ac]	607 ± 16.3[b]	649 ± 19.6[d]

Values are arithmetical means ± S.E., values with superscripts differ ab $P<0.05$, cd $P<0.01$.

Table 2. **Fertility parameters of the first parity Estonian Holstein cows grouped by BCS at parturition**

Fertility parameters	Body condition score at calving		
	≤3.0 (n = 26)	3.25–3.5 (n = 39)	≥3.75 (n = 21)
Interval calving to first service (days)	91 ± 4.1	83 ± 3.5	88 ± 5.4
First service conception rate (%)	17	23	0
Service period (days)	82 ± 14.4	72 ± 13.9	77 ± 15.8
Days open (of those pregnant)	173 ± 13.7	155 ± 14.8	165 ± 16.6
Services per conception	3.0 ± 0.36	3.0 ± 0.32	3.6 ± 0.42
Number of cows not pregnant	1	5	5

Values are arithmetical means ± S.E.

Table 3. Culling reasons among the first parity Estonian Holstein cows grouped by BCS at parturition

Culling reason	Body condition score at calving		
	≤3.0 (n = 29)	3.25 – 3.5 (n = 48)	≥3.75 n = (27)
Udder diseases	3	4	7
Reproductive disorders	0	2	2
Feet and leg disorders	1	3	0
Other reasons	0	3	2
Total	4 (14%)	12 (25%)	11(41%)

Discussion. In this study the objective was to investigate the performance of the first lactation Estonian Holstein cows in relation to their BCS near calving. BCS is an animal characteristic that reflects feeding and management, in addition BCS before calving influences dry matter intake. According to the review of Broster and Broster (1998) the majority of experiments have showen a reduction in dry matter intake (DMI) with the increase in BCS at calving; intensive use of body reserves leads to high plasma NEFA levels that inhibit cows' appetite and lead to low DM intake (Overton and Waldron, 2004). Because cows in higher body condition eat less, they are likely to be in a more negative energy balance compared with cows having lower body condition score and fed the same diet (Grummer et al., 2004). Several studies have shown that the duration and magnitude of condition loss depended primarily on BCS at calving and was greater for cows that calved with higher condition scores (review by Broster and Broster 1998). This conclusion is in accordance with the results of our study; the amount of BCS loss of *fat* cows was more than double and their BCS decline to nadir lasted significantly longer time compared to the *thin* cow group revealing more severe negative energy balance (NEB) in fat cows. At the same time mobilization of adipose tissue and muscle fibre helps to cover the lack of energy during the early lactation period, a 1-unit decrease in BCS for a cow weighing 650 kg at calving would provide the amount of energy to support the production of 564 kg of 4 percent fat-corrected milk (NRC, 2001). Pedron et al. (1993) reported that although BCS at calving did not affect milk production, net decrease of 1 unit BCS corresponded to a 422 kg increase in 305-day milk production. These results point out the importance of having adequate body reserves available to support high milk yield. However, several studies dealing with relations between BCS at calving and milk yield have been conflicting (review by Broster and Broster, 1998). Markusfeld et al. (1997) reported better milk fat and protein production during the first 90 days of lactation in cows calving in higher body condition. In contrast, Ruegg and Milton (1995) found that BCS at calving affected neither peak nor 305-day milk yield.

Waltner et al. (1993) found that 3.5% FCM production to 90 days postpartum was maximised at a score of 3.5-4 for first lactation animals. In our study, based on the amount of BCS decline, *fat* and *moderate* cows used more body reserves and produced significantly more milk fat and FCM during the 305-day period compared to the *thin* cow group.

A number of studies indicate that the severity and duration of the NEB may be influenced by the genetic merit for milk yield (Veerkamp et al., 1994, Buckley et al., 2000). In our study the GM index of the *thin* cow group was significantly higher compared to the *fat* and *moderate* cow groups. At the same time *thin* cows had the lowest and shortest BCS decline revealing to the less intensive use of body reserves after calving. During the first and second month of lactation the milk fat percentage and FCM production of *fat* cows exceeded the *thin* cow production significantly. We assume that the *thin* cows could not cover their high need for energy, and they could not realize their genetic potential for milk production as they had no sufficient amount of body reserves to sustain quick growth in milk yield at the beginning of lactation. Additional body energy reserve might be needed to support the milk yield.

During the postpartum NEB, changes in milk composition in response to nutrient deficiency can be used as indicators of energy balance and fertility prognosis; the fat to protein ratio can reflect inadequate energy intake (Heuer et al*.*, 1999; De Vries and Veerkamp, 2000). In our study the milk fat/protein ratio of the *fat* cow group was near to 1.4 during the first month of lactation indicating an energy deficit, according to Pehrson (1996). This leads to the inference that cows of the *fat* group used more body energy reserves during the first month of lactation and had a more severe NEB compared to the other two groups. This conclusion is also in accordance with the significantly greater BCS loss of the *fat* cows during the 30-day period after calving.

Senatore et al. (1996) report that NEB during the 1st month of lactation is detrimental for the recovery of ovarian function in first lactation Holstein dairy cows. In the same study it was found that BCS at calving and body condition loss were not significantly related to the days to first ovulation. The authors assume that manual BC scoring might not be sensitive enough to reveal changes in energy balance. However, Markusfeld et al. (1997) found in primiparous cows a reduction of six open days for each additional unit of body condition at calving. Lopez-Gatius et al. (2003) found in a meta-analysis that BCS at parturition was associated with the relative risk for conception only in cows showing a low BCS at parturition, and BCS change during the early lactation period was not associated with the relative risk for conception: cows in good BCS at calving had significantly reduced days open. In contrast, Heuer et al. (1999) found that fat cows were less likely to conceive at first service than were cows in normal condition. This conclusion is in accordance with the results of our study, *fat* cows did not conceive from the first service and this led to higher number of services per conception in this group compared to the other two groups. Butler (2000) has also referred to several studies and pointed out that cows losing one unit or more BCS during early lactation are at greatest risk for low fertility with conception rates 17 to 38 %. According to Britt (1992) the long-term effect of NEB might impair the health of preovulatory oocytes and follicles and reduce progesterone concentrations after ovulation. Thus, high BCS of the *fat* cow group near calving and subsequent BCS loss more than one unit might be a risk factor for impaired conception in this group. Other fertility parameters like interval from calving to first service, service period, and days open did not differ significantly among the three groups investigated, but a more complete analysis of the reasons of overall low fertility of the three groups of cows remains out of the scope of this study.

Research results concerning the relationships between BCS at calving and health disorders and culling are controversial. Ruegg and Milton (1995) found no relationship between BCS at calving and disease diagnosis, but the proportion of cows overconditioned at calving (BCS ≥4.0) in that study was less than 7%. In the study of Heuer et al., (1999) the cows of fat to protein ratio >1.5 had higher risks for ketosis, ovarian cyst, displaced abomasums, lameness and mastitis. In our study 27 cows out of 104 (27%) were culled due to various reasons during the first lactation, furthermore, 8 cows (30% of cows culled) left the herd during the first 60 days after calving. Udder diseases were the major reason for culling. *Fat* cows had significantly more cullings (41%) compared to *thin* cows (14%). Goff and Horst (1997) have pointed out that immunosuppression increases with deficiencies of energy, protein, minerals or vitamins, the situation that the *fat* dairy cows were most predisposed to in early lactation. Thus, infections may become clinically apparent during the first weeks after calving.

While making suggestions about the proper BCS at calving we have to bear in mind that the genetic potential, body size and available feed all need to be considered when interpreting BCS or making recommendations about desired BCS (McNamara, 2000). In spite of greater milk production the first lactation cows classified *fat* in this study had also several shortages like poor first service conception, high culling rate, and high metabolic load during the first month of lactation. Cows calved in BCS classified *thin* could not realise their genetic potential for milk production due to lack of body reserves. Thus, we consider that while taking into account besides milk production the aspects of health and fertility, the reasonable BCS at calving of first lactation Estonian Holstein cows in the present management and feeding conditions was that of *moderate* 3.25–3.5 BC units.

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