



Influence of feto-pelvic disproportion on milk cows fertility

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Abstract. The aim of the study was to evaluate relations between feto-pelvic proportion and further fertility of milk cows, select proportions and critical values of disproportion best predicting cows with lower fertility as a result of difficult calving as well as to evaluate fertility of cows selected on the basis of chosen criteria. The study was carried out on black-and-white and red-and-white Polish Holstein-Friesian cows in six farms diversified by the number of livestock (from 10 to 20 to over 180 cows) and milk yield (from 6.563 –

9.788 kg/305 days). In total 100 parturitions were analysed (one in each cow) resulting in giving birth to one calf, without complications related to foetus presentation, posture, and position or the need for caesarean section or fetotomy and retained placenta. Analysed parturitions were the result of artificial insemination pregnancies in 53 cases with semen from 33 polish-HF bulls and in 47 cases with semen from 26 the world HF bulls. Considering critical values of chosen fetopelvic proportions, there is possibility of choosing cows, where more than every third cow had usually delayed over 90 days calving-conception period and more than every fourth became pregnant after at least three inseminations.

Keywords: milk cows; fetopelvic disproportion; fertility indices.

Introduction

Increase of difficult calvings percentage observed in dairy cows breeding all over the world is partially the result of introduction of Holstein-Friesian cattle genes (1-5). In homogenous groups of cows depending on age structure there are 2-7% of difficult calvings a year. The United States is an exception, where the percentage of cases is higher (heifers – 22.6%, cows – 9.6%) (6). High percentage of difficult calvings in the USA results from herds size, insufficient selection for easy calving, as well as inadequacy of maintenance and organization of parturitions. Putting easy calving feature on selection index, despite its low heredity (0.02-0.09), may reduce tendency to increase difficult calvings number. It has been found that in countries using selection indices in relation to calving, difficult parturitions percentage is lower, despite the influence of breed, maintenance and environment (2, 7).

The ranking of direct causes of difficult calvings changes with cows age (8). In heifers, the most important is fetopelvic disproportion (FPD), whereas in multiparous cows, the most common are foetus presentation, posture, and position abnormalities. Other causes include uterine inertia, cervical and vaginal stenosis, as well as torsion of gravid uterus. However, fetopelvic disproportion is statistically the most important factor influencing parturition and as a consequence the loss of newborn calves or further cow fertility (3, 4, 9-11).

In cows after difficult calving, first heat and insemination are delayed, calving index decreases, number of inseminations per pregnancy increases, and intercalving period is longer (2, 12-14). Direct causes of lower fertility in cows include longer time of uterine involution, delay of first ovulation, and disturbance in progesterone secretion (15, 16). Cows with difficult parturition history also have problems with subsequent calvings. As a result of numerous early or late consequences of difficult parturition, costs of treatment increase, and their late diagnosis additionally worsens herd reproductive indices (8). Herds where difficult parturitions occur more often focus attention of breeders, veterinarians, and researchers, forcing them to evaluate risk factors and take prophylactic measures.

However, objective assessment of parturition is difficult because of subjective character of phenotypic criteria of classifying calvings as "easy" or "difficult." It has been suggested that although real percentage of difficult parturitions is lower, as many as 50% of calvings are human-assisted (3, 17).

Fertility indices improvement in herds of cows can be obtained by early selection of females at risk of complicated uterine involution (endometritis), detailed diagnostic examination, and early treatment. Due to subjective character of phenotypic evaluation of parturition, the aim of the study was to compare proportions between morphometric and pelvimetric parameters of new-born calves of randomly selected group of cows with their subsequent fertility as well as to evaluate the selecting criteria of females at risk of lower fertility as a result of fetopelvic disproportion.

Materials and methods

Polish HF cows:	Herd						Together (n)
	A	B	C	D	E	F	
black-and-white	30	13	25	7	8	6	89
red-and-white	2	1	2	0	2	4	11
Together – n	32	14	27	7	10	10	100

Experimental materials: The study was carried out on black-and-white ($n = 89$) and red-and-white ($n = 11$) Polish Holstein-Friesian cows reared at six farms. The number of cows and their average milk yield in standard lactation (305 days) during observation period were: herd A – 32 cows (9.248 kg/305 DIM), herd B – 14 cows (6.563 kg/305 DIM), herd C – 27 cows (7.534 kg/305 DIM), herd D – 7 cows (7.400 kg/305 DIM), herd E – 10 cows (9.008 kg/305 DIM), herd F – 10 cows (9.788 kg/305 DIM) respectively. In four farms, animals were kept in tie-up barns, and in two farms, in free stall barns. Calvings took place in separate rooms, where cows were moved 2 weeks before planned date of parturition. In total 100 parturitions have been analysed (one in each cow) resulting in giving birth to one calf, without complications related to foetus presentation, posture, and position or the need for caesarean section, or fetotomy and retained placenta. Additional criterion for cows selection for analysis was another pregnancy after insemination at the end of postparturient period. Among analysed calvings ($n=100$) 16 took place in spring, 22 in summer, 49 in autumn, and 13 in winter. Forty five heifer calves and 55 young bulls were born as a result of pregnancies of average length 278 ± 7 days. All pregnancies were the result of artificial insemination – in 53 cases with semen from 33 domestic HF bulls, and in 47 cases, with semen from 26 foreign HF bulls from USA ($n = 9$), Canada ($n = 5$), France ($n = 4$), Holland ($n = 3$), Denmark ($n = 3$), and Switzerland ($n = 2$).

Experimental methods: Pelvimetric examination was performed 14 days before parturition by measuring outer distance between sciatic and coxal tubers at the same side (pelvis length) and at the opposite sides (pelvis diagonal), and between two sciatic tubers and coxal tubers (pelvis width). Age of heifers (22 cows), primiparas (17 cows), and multiparas (61 cows) on the day of parturition was on average 26.9 ± 3.4 , 37.6 ± 7.3 , and 78.4 ± 27.6 months, and HF gene share $91.0 \pm 9.0\%$, $92.1 \pm 6.7\%$, and $85.1 \pm 16.6\%$. In analysed population of cows, 20 were not registered in breed register for dairy cattle. These were 4 heifers, 1 primipara, and 15 multiparas with average HF gene share $62.9 \pm 12.5\%$. Forty one cows were in initial breed register (average HF gene share – $89.7 \pm 2.8\%$) and 39 were in main breed register (average HF gene share – $98.1 \pm 2.1\%$).

Among studied animals registered in breed registers were 18 heifers, 16 primiparas, and 46 multiparas.

Morphometric examinations of new-born calves were performed on the day of parturition. The measurements included body weight and head width at temporal bone, trunk width at shoulders and hips, head circumference from the bottom of the mandible to occipital bone as well as chest circumference just behind scapular bones. Among studied calves in most cases one (36 cases) or two (16 cases) offsprings of one bull were examined. In two cases, morphometric examinations were performed in three and four offsprings. There were also cases where five, six, and seven offsprings of one bull were examined.

In all farms, examined cows were under supervision of local veterinarian. Cows showing post-parturient metritis, clinical metritis, or endometritis were treated with antibiotics systemically and/or locally (recognition based on general signs, characteristics of discharge obtained during examination per vaginam, and rectal palpation of uterus – definition suggested by Sheldon et al. (18)). Cows fertility after calving was assessed on the basis of analysis of the date of first and subsequent inseminations. Their efficiency, total number of inseminations until pregnancy were determined per rectum over 42 days after insemination. The percentage of "repeating" cows, and cows culled due to infertility as well as the length of calving-conception period were also determined.

Statistics: Comparisons of mean values of cows pelvimetric measurements, calves morphometric examinations, coefficients of proportions changeability between them, as well as selected indices of fertility, were performed using one-way analysis of variance and division into homogeneous groups was done using Student-Newman-Keuls test. The correlation among measurable fertility indices (length of calving-conception period and number of inseminations per pregnancy/without reinsemination) and indices of proportions of size of new-born calf to size of mother's pelvis was assessed using Pearson's correlation coefficient. In order to determine critical values of feto-pelvic disproportions, proportion ranges were set using categorization method based on integers. Critical values for each range were tested with respect to efficiency of division of the studied cows

into statistically maximally diversified by the incidence of cows with prolonged calving conception period (CCP > 90 days) and non-pregnant cows after two inseminations (repeating cows). The deciding criterion of the efficiency of division were the results of logistic regression performed for each proportion separately as well as for interaction between them. The P values (statistical significance) within the range of 0.10–0.05 were used as tendency markers, whereas values < 0.05 confirmed higher percentage of cows with lower fertility after calvings with feto-pelvic disproportion. The data were analysed using STATISTICA 7.1 StatSoft®-PL software.

Results

Results of external pelvis measurements in heifers, primiparas, and multiparas presented in Table 1 did not differ statistically. Morphometric examinations of new-born calves (Table 2) confirmed common opinion concerning bigger size of young bulls in comparison with heifer calves

Table 1. Results of heifers, primiparas and multiparas pelvis measurements during last month of pregnancy (mean ± standard deviation)

1 Measurement (in cm):	Group of cows:		
	heifers (n = 22)	primiparas (n = 17)	multiparas (n = 61)
[1] distance between sciatic tubers	26.3 ± 1.0	26.1 ± 1.0	26.5 ± 1.5
[2] distance between coxal tubers	51.8 ± 3.4	49.9 ± 3.7	51.1 ± 4.5
[3] distance between coxal and sciatic tubers on the opposite side – diagonal	63.3 ± 3.5	61.5 ± 3.1	62.2 ± 3.9
[4] distance between coxal and sciatic tubers on the same side	51.8 ± 3.2	50.7 ± 4.0	50.8 ± 4.2
[5] pelvis circumference	204.8 ± 9.7	199.0 ± 8.5	202.1 ± 12.1

1 [...] symbol of measurement; 2 diagonal mean; 3 mean of measurements on the right and left side; 4 sum of distances between coxal and sciatic tubers and distance between sciatic and coxal tubers on the opposite side – diagonals; abc P < 0.05.

verified statistically with respect to body weight and head circumference of new-born calves. Differences in proportions of newborns' sexes were not statistically confirmed in diversified by numbers of deliveries groups of females despite a bit bigger number of delivered calves (Table 3). High-

Table 2. Results of new-born calves morphometric measurements with respect to sex (mean \pm standard deviation)

Measurement (in cm):	New-born calf sex:	
	heifers (n = 45)	bulls (n = 55)
[A] body weight (kg)	36.7 \pm 4.9 ^a	39.5 \pm 4.6 ^b
[B] head width (cm)	14.9 \pm 1.4	15.2 \pm 1.7
[C] shoulders width (cm)	19.6 \pm 1.3	20.0 \pm 1.4
[D] hips width (cm)	20.4 \pm 2.2	20.5 \pm 1.8
[E] head circumference (cm)	51.9 \pm 1.7 ^a	53.3 \pm 3.1 ^b
[F] chest circumference (cm)	80.2 \pm 6.0	80.7 \pm 4.8

1[...] symbol of measurement; ab P < 0.05.

Table 3. Sex of new-born calves and selected fertility indices of cows after calving

Index:	Group of mother		
	after first calving (n = 22)	after second calving (n = 17)	after third and more calvings (n = 61)
number of new-born heifers	13	10	32
number of newborn bulls	9	7	29
date of 1st insemination (days after calving)	85.8 \pm 14.0	81.4 \pm 11.0	81.9 \pm 9.6
pregnancy index after 1st insemination (%)	81.8 ^b	70.6 ^{ab}	50.9 ^a
insemination index	1.41 \pm 0.91 ^{ab}	1.29 \pm 0.47 ^a	1.84 \pm 1.03 ^b
calving-conception period (days)	94.1 \pm 22.1 ^{ab}	84.2 \pm 13.8 ^a	98.6 \pm 25.6 ^b

abc P < 0.05.

er index of calving after first insemination and lower insemination index were observed at younger cows whatsoever, with the consequence of differences in the length of calving-conception period. The greatest variability concerned proportions between head width and head circumference, as well as new-born calves chest circumference and mothers' pelvis size ($P < 0.05$ – data not in Tables). The range of alternations regarding examined proportions was observed not significant by comparing the mass of new-borns' bodies, the width of shoulders' and hips to measurements of the mothers' pelvis.

In studied population of cows, the length of calving conception period and the number of inseminations per pregnancy only in some cases were correlated with feto-pelvic proportion determined at calving (Table 4). The highest values of correlation coefficients refer to proportions from

Table 4. Correlation coefficient between fertility indices and size proportion of new-born calf and mother's pelvis (r – correlation coefficient, P – statistical significance)

¹ Analyzed proportion:	² Fertility index	
	calving-conception period	number of inseminations per pregnancy
A:1	r = -0.017 P = 0.872	r = 0.032 P = 0.760
A:2	r = 0.093 P = 0.371	r = 0.063 P = 0.547
A:3	r = 0.117 P = 0.262	r = 0.109 P = 0.295
A:4	r = 0.135 P = 0.195	r = 0.123 P = 0.237
A:5	r = 0.095 P = 0.360	r = 0.089 P = 0.393
B:1	r = 0.067 P = 0.521	r = 0.197 P = 0.057
B:2	r = 0.157 P = 0.131	r = 0.182 P = 0.079
B:3	r = 0.195 P = 0.059	r = 0.252 P = 0.014
B:4	r = 0.204 P = 0.049	r = 0.251 P = 0.015
B:5	r = 0.175 P = 0.092	r = 0.234 P = 0.023
C:1	r = 0.014 P = 0.889	r = 0.144 P = 0.165

Table 4. Correlation coefficient (continued)

¹ Analyzed proportion:	² Fertility index	
	calving-conception period	number of inseminations per pregnancy
C:2	r = 0.152 P = 0.144	r = 0.146 P = 0.159
C:3	r = 0.209 P = 0.043	r = 0.245 P = 0.017
C:4	r = 0.221 P = 0.032	r = 0.247 P = 0.016
C:5	r = 0.183 P = 0.078	r = 0.222 P = 0.031
D:1	r = -0.014 P = 0.892	r = 0.045 P = 0.667
D:2	r = 0.089 P = 0.391	r = 0.061 P = 0.562
D:3	r = 0.131 P = 0.207	r = 0.128 P = 0.219
D:4	r = 0.152 P = 0.144	r = 0.143 P = 0.169
D:5	r = 0.104 P = 0.320	r = 0.101 P = 0.330
E:1	r = -0.049 P = 0.640	r = 0.140 P = 0.178
E:2	r = 0.106 P = 0.310	r = 0.138 P = 0.184
E:3	r = 0.156 P = 0.134	r = 0.236 P = 0.022
E:4	r = 0.166 P = 0.109	r = 0.228 P = 0.027
E:5	r = 0.128 P = 0.220	r = 0.217 P = 0.036
F:1	r = 0.033 P = 0.755	r = 0.146 P = 0.160
F:2	r = 0.145 P = 0.164	r = 0.135 P = 0.196
F:3	r = 0.204 P = 0.049	r = 0.228 P = 0.027
F:4	r = 0.209 P = 0.043	r = 0.227 P = 0.028
F:5	r = 0.176 P = 0.089	r = 0.202 P = 0.050

1,2 notation according to Tables 1 and 2.

comparison of head width and circumference, shoulders width and chest circumference of new-born calves with mother's pelvis length, its diagonal, and circumference. The lack of significant relationship ($P < 0.05$) or "correlation" tendency ($0.05 \leq P < 0.10$) among fertility indices and other

proportions were the reason to exclude them from further analysis. Results presented in Tables 5 and 6 estimate the accuracy of critical values selection for different feto-pelvic proportions, thanks to which there is a possibility to select from whole population of cows where significant disproportion could be the cause of lower fertility. As correctness criterion of choosing critical value for given proportion was the comparison of percentage of cows with calving-conception period > 90 days with cases where more than two inseminations were necessary to get the cow pregnant.

In five cases (B:3/B:4/B:5/E:3/F:3), we found critical values of feto-pelvic proportions significantly differing ($P < 0.05$) population

Table 5. Critical values of analyzed feto-pelvic proportions and statistics with respect to percentage of cows with calving-conception period (CCP) over 90 days

¹ Analyzed proportion:	Critical value of proportion:	² Cows with CCP > 90 days (% vs. %)	Wald Chi2 statistic	³ AOR	P value
B:3	0.30	53.8 vs. 20.0	13.7049	5.8235	0.00036
B:4	0.24	55.0 vs. 20.4	12.6484	5.7778	0.00060
B:5	0.80	60.0 vs. 24.6	9.4841	4.5882	0.00273
C:3	0.40	45.9 vs. 26.3	3.7725	2.3800	0.05516
C:4	-	-	no critical value found ($P > 0.1000$)		
C:5	0.95	40.0 vs. 18.2	3.2099	2.5555	0.07648
E:3	1.00	45.3 vs. 19.5	6.5133	3.4138	0.01235
E:4	-	-	no critical value found ($P > 0.1000$)		
E:5	-	-	no critical value found ($P > 0.1000$)		
F:3	1.60	51.4 vs. 23.7	7.2106	3.4034	0.00860
F:4	1.30	46.3 vs. 26.0	3.0280	2.1631	0.08518
F:5	-	-	no critical value found ($P > 0.1000$)		

¹ notation according to tables 1 and 2; ² percentage of cows with CCP over 90 days in group with exceeded critical value of proportion vs. other cows; ³ adjusted odds ratio (AOR).

Table 6. Critical values of fetopelvic proportions and statistics with respect to percentage of „repeating” cows

¹ Analyzed proportion:	Critical value of proportion:	² „Repeating” cows (% vs.%)	Wald Chi2 statistic	³ AOR	P
B:3	0.30	28.2 vs. 12.7	3.3827	2.694	0.0691
B:4	0.24	37.5 vs. 13.0	3.0185	2.547	0.0857
B:5	-	-	no critical value found (P > 0.1000)		
C:3	0.40	29.7 vs. 12.3	4.1853	3.022	0.0436
C:4	-	-	no critical value found (P > 0.1000)		
C:5	-	-	no critical value found (P > 0.1000)		
E:3	1.00	30.2 vs. 4.9	7.3893	8.432	0.0078
E:4	0.85	23.3 vs. 11.5	4.1162	3.067	0.0454
E:5	2.60	26.5 vs. 11.1	3.4135	2.889	0.0679
F:3	1.60	34.3 vs. 10.2	7.4744	4.609	0.0075
F:4	1.30	29.5 vs. 10.0	5.3230	3.774	0.0233
F:5	4.00	27.5 vs. 13.0	3.0185	2.547	0.0857

¹ notation according to tables 1 and 2; ² percentage of „repeating” cows in group with exceeded critical value of proportion vs. other cows; ³ adjusted odds ratio (AOR).

with regard to percentage of females with CCP > 90 days. Three cases (C:3/C:5/F:4) demonstrated a tendency ($0.05 \leq P < 0.10$), and in four (C:4/E:4/E:5/F:5), such a tendency was not found ($P > 0.10$). Also, in case of five fetopelvic proportions (C:3/E:3/E:4/F:3/F:4), chosen critical values allowed for selecting a group of cows with increased percentage of „repeating” cases ($P < 0.05$), four (B:3/B:4/E:5/F:5) demonstrated a tendency ($0.05 \leq P < 0.10$), and in case of three proportions (B:5/C:4/C:5), critical values were not found ($P > 0.10$). The assumption was correct ($P < 0.05$) with regard to two fertility indices in cows for two proportions (E:3 and F:3), whereas in four (B:3/B:4/C:3/F:4), one comparison demonstrated a tendency. Among aforementioned proportions that exceeded

values of E:3 > 1.00 and F:3 > 1.60 as well as C:3 > 0.40 or F:4 > 1.30 very accurately (P < 0.015) marked out cows at risk of prolonged calving-conception period (52.2% vs. 25.0%) and lack of pregnancy after two inseminations (35.2% vs. 11.1%) (Table 7). In groups of cows with two or three disproportions the pregnancy index after 1st insemination and the calving conception period differed statistically from the control group (Table 8).

Table 7. Selection efficiency of cows with longer calving-conception period (CCP) and „repeating” cows in groups diversified by feto-pelvic disproportion criteria

¹ Criteria of disproportion evaluation:	Cows with CCP > 90 days				² „Repeating” cows			
	² Proportion (% vs. %)	Wald Chi ² statistic	³ AOR	P	² Proportion (% vs. %)	Wald Chi ² statistic	³ AOR	P
E:3 F:3	51.4 vs. 23.7	7.2106	3.403	0.0086	34.3 vs. 10.2	7.4744	4.609	0.0075
E:3 F:3 B:3	53.8 vs. 26.5	6.0025	3.241	0.0162	26.9 vs. 16.2	-	-	> 0.05
E:3 F:3 B:4	53.8 vs. 26.5	6.0025	3.241	0.0162	26.9 vs. 16.2	-	-	> 0.05
E:3 F:3 C:3	53.6 vs. 25.8	6.4809	3.326	0.0126	35.7 vs. 12.1	6.5180	4.028	0.0123
E:3 F:3 F:4	51.6 vs. 25.4	6.1254	3.133	0.0152	35.5 vs. 11.1	7.2777	4.400	0.0083

¹ notation according to tables 1 and 2; ² percentage of cows with CCP over 90 days or „repeating” cows in group with exceeded values of E:3 > 1.00 and F:3 > 1.60 vs. others, E:3 > 1.00. F:3 > 1.60 and B:3 > 0.30 vs. others, E:3 > 1.00. F:3 > 1.60 and B:4 > 0.24 vs. others, E:3 > 1.00. F:3 > 1.60 and C:3 > 0.40 vs. others, E:3 > 1.00. F:3 > 1.60 and F:4 > 1.30 vs. others; ³ adjusted odds ratio (AOR).

Table 8. Selected fertility indices of cows after calving in groups with fetopelvic disproportion and control

Index:	¹ Criteria of disproportion evaluation:	² Group		
		with disproportion in all criteria	with disproportion not in all criteria	control
date of 1st insemination (days after calving)	E:3 F:3	83.4 ± 17.4	82.9 ± 2.6	82.1 ± 4.7
	E:3 F:3 C:3	83.3 ± 17.5	84.4 ± 11.6	81.8 ± 4.2
	E:3 F:3 F:4	83.3 ± 18.5	82.1 ± 5.2	82.6 ± 5.2
pregnancy index after 1st insemination (%)	E:3 F:3	48.6a	50.0a	78.0b
	E:3 F:3 C:3	42.9a	64.7ab	71.4b
	E:3 F:3 F:4	48.4a	58.8ab	71.7b
insemination index	E:3 F:3	1.97 ± 1.12b	1.83 ± 1.04ab	1.27 ± 0.55a
	E:3 F:3 C:3	2.07 ± 1.15b	1.71 ± 1.10ab	1.37 ± 0.63a
	E:3 F:3 F:4	2.00 ± 1.15b	1.65 ± 0.93ab	1.39 ± 0.71a
calving-conception period (days)	E:3 F:3	103.7 ± 29.5b	97.3 ± 24.8b	86.5 ± 11.7a
	E:3 F:3 C:3	106.1 ± 29.6b	96.9 ± 28.8ab	87.9 ± 13.1a
	E:3 F:3 F:4	104.5 ± 31.1b	93.3 ± 21.6ab	89.1 ± 15.1a

¹ notations according to tables 1 and 2; ² with disproportion: E:3 > 1.00 and F:3 > 1.60 (n = 35); E:3 > 1.00, F:3 > 1.60 and C:3 > 0.40 (n = 28) or E:3 > 1.00, F:3 > 1.60 and F:4 > 1.30 (n = 31); controls: E:3 ≤ 1.00 and F:3 ≤ 1.60 (n = 41), E:3 ≤ 1.00, F:3 ≤ 1.60 and C:3 ≤ 0.40 (n = 49) or E:3 ≤ 1.00, F:3 ≤ 1.60 and F:4 ≤ 1.30 (n = 46); with disproportion not in all criteria: n = 18, n = 17 and n = 17 respectively; abc P < 0.05.

Discussion

The lack of differences among mean values of external pelvis measurements in pregnant heifers in relation to older cows (primiparas and multiparas) signifies similar level of somatic size of young cows. It is worth emphasizing that first calving in heifers took place between 23 and 36 month of life (on average 26.9 ± 3.4), which is in keeping with breeding recommenda-

tions concerning optimal time of breeding maturity, first insemination/covering, and date of first calving. It was calculated that the level of, infusion” of HF genes in studied population was the lowest in group of cows calving at least for the third time ($85.1 \pm 16.6\%$). It is known that size of HF female cows is bigger than analogous in native breeds of dairy cattle. It allows to assume that lower share of genes of this breed in older cows was the cause of higher percentage of feto-pelvic disproportion in aforementioned group. Assuming the index of selection of cows at risk of difficult calving feto-pelvic disproportion of E:3, F:3 and C:3 or E:3, F:3 and F:4 more than 2/3 of cows ($25/36 - 69.4\%$ or $20/30 - 66.7\%$ respectively) were cows calvings at least for the third time.

Comparison studies confirm positive correlation among internal and external pelvimetric measurements irrespective of the method of measurement (bow compass, Rice pelvimeter, computer tomography) (8, 19, 20). However, there is some variability that differs particular external and internal measurements, and which is not the result of differences of the precision of measurements. Variability differences can also be observed comparing results of different morphometric measurements in calves (21). This shows that the use of feto-pelvic proportion as objective criterion to evaluate the difficulty at calving requires standardization.

According to affected examinations, disproportion is not reflected at the same level as all proportions between measurements at calves and pelvic measurements of their mothers. Assuming a priori the relationship, emphasized in literature, between the course of calving and further cow fertility, we selected proportions and critical values of disproportions that best select cows with prolonged calving-conception period and calving difficulties. New-born calves measurements (head, pectoral girdle, chest) chosen on the basis of mathematical analysis reflect the moments during parturition when foetus trunk traveling through birth canal makes it difficult or slows down the moment of pushing out the foetus. Similarly, simple external measurement of the length of pelvis diagonal and circumference also characterizes precisely size of birth canal. Morphometric measurements of new-borns together with external pelvimetric measurements of mothers might be faulty. To minimise number of faults considering

improper typing of cows after deliveries with feto-pelvic disproportion, one should confirm its presence taking under consideration more parameters to compare. “Disproportion” according only to one measurement at the mother and the new-born might be doubtful. Fertility of cows in groups “control” (all proportions considered under limiting values), with “disproportion” (all proportions considered over limiting values) and in cows with disproportion only according to some parameters of mother and new-born calf, was presented in Table 8 to emphasise aforementioned facts. As it is observed in the comparison, the index of conception after first insemination, insemination index together with calving conception period in the group with disproportion to that of partially considered parameters of mother and calf to have average values.

They don't differ significantly from corresponding ones in cows with “disproportion” and “control”. Moreover, it confirms cows group with doubtful diagnosis contains cows after deliveries either with actual “disproportion” or faulty one. Comparison of calving efficiency after first insemination and length of calving-conception period suggests higher accuracy of cow's selection on the basis of three and not two proportions (Table 8). This is confirmed by the lack of statistically better values of these indices in cows with single disproportion when evaluation criterion is the ratio of head and chest circumference to pelvis length.

It is disputable that there is no connection between the proportion of new-born calves weight and the mother's pelvis and the feto-pelvic disproportion assessed on the basis of fertility indices. Calf weight is very often used as a criterion in determining reasons of difficult calving due to easy measurement (11). However, correlation among weight and other morphometric measurements is poor (22). The lack of statistically confirmed difference among body weight of new-born calves diversified by sex suggests small morphometric differences between offsprings. This emphasizes the importance of proportions demonstrated in our own study as sensitive parameters of evaluation of feto-pelvic disproportion. Using critical values for feto-pelvic disproportion with regard to proportion of head and chest circumference to pelvis length, as well as shoulder width vs. pelvis length or chest circumference vs. pelvis circumference, we

can select cows group in which more than every third cow will have over 90 days calving conception period and more than every fourth becomes pregnant after at least three inseminations.

Conclusions

Monitoring the cases of feto-pelvic disproportion seems to be justified because of at least two reasons. Firstly, it shows that process of “Holsteini- zation” of domestic headage of cattle requires selection of bull’s semen not only for heifers but also older cows. Secondly, due to subjective criteria of phenotypic assessment of calving course, the estimation of feto-pelvic disproportion is simple, objective and quite efficient method of selecting cows at risk of lower fertility. The selection of such cows may be of special importance in herds where there is a lack of permanent and systematic gynaecological supervision and significant percentage of cows with ferti- lity disturbances.

Abbreviations

HF cows,	Holstein-Frisian cows
DIM,	days in milk
CCP,	Calving Conception Period
AOR,	adjusted odds ratio

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