ACTA SCIENTIARUM POLONORUM

Acta Sci. Pol. Zootechnica 19(3) 2020, 23–30

www.asp.zut.edu.pl pISSN 1644-0714 eISSN 2300-6145 DOI:10.21005/asp.2020.19.3.03

ORIGINAL PAPER

Received: 03.04.20
Accepted: 02.09.20

BODY CONDITION OF FEMALE MINK (*NEOVISON VISON*) AFFECTS REPRODUCTION PERFORMANCE AND BEHAVIOR IN PREGNANCY AND NURSING

Lidia Felska-Błaszczyk[1], Beata Seremak[2]

[1]Department of Animal Anatomy and Zoology, West Pomeranian University of Technology, Klemensa Janickiego 33, 71-270 Szczecin, Poland
[2]Department of Animal Reproduction Biotechnology and Environmental Hygiene, West Pomeranian University of Technology, Klemensa Janickiego 29, 71-270 Szczecin, Poland

ABSTRACT

The study was aimed to evaluate a possible effect of body condition of female farmed mink (*Neovison vison*) at the moment of conception on their prospective reproduction and behavior. 601 Perl mink females at age 1 and 2 years were assigned to one of five groups according to their body condition. The following parameters were analyzed: gestation and diapause lengths, litter size, live-born litter size, number of weaned per litter, female barrenness, and the incidence of fur-chewing. The effect of body condition was more pronounced in yearling females, where the largest litters, the highest number of live-born per litter, and the highest weaning success were found in the group with the ideal body condition. In both age groups, the shortest pregnancies and diapause periods were observed in the thinnest females. Fur-chewing was most often noticed in either the thinnest or the most obese animals; females of these groups also exhibited the highest rates of barrenness. Consequently, the lowest incidence of fur-chewing, female barrenness were found in females with ideal body condition.

Key words: mink, body condition, behavior, reproduction, mating

INTRODUCTION

Mink autumn feeding is highly intensive and involves an energy-rich diet, since the breeding stock animals must accumulate necessary reserves of fat before winter. The same feeding system is applied to slaughter animals, in order to obtain the largest possible body size and, in consequence, the largest and the most valued pelt. Regardless of its purpose, however, the high-intensity nutrition regimen inevitably leads to obesity, especially as the feed often contains crude fat. Consequently, the prospective breeders should be brought back to the so called breeding condition; the low-intensity feeding regimen involves a short period of applying a poorer diet in terms of both quantity and energy, especially low in fat. This feeding mode ends 4–5 days before initiation of matings, when the flush feeding, i.e. the full ration of high-energy feed, is applied [Tauson 1985, Tauson 1988, Tauson 2001]. Despite the conditioning of the breeders, however, some females will fail to return to the ideal condition; some may grow too lean while others will remain too fat. Bis-Wencel et al. [2018] emphasize that breeding stock animals are primarily susceptible to obesity, which may also lead to health problems. The authors found that both an excess and a deficit of fat in the nutrition for mink may result in diabetes, whereas hyperglycemia or glucose deficiencies may significantly affect reproduction [Hynes et al. 2004, Rouvinen-Watt and Armstrong 2004, Hynes and Rouvinen-Watt 2007, Bis-Wencel et al. 2018].

Many authors report that the appropriate body condition in the breeding stock is the key to a satisfactory breeding performance [Baekgaard et al. 2008, Boudreau 2012, Boudreau et al. 2014]. Boudreau [2012] and Boudreau et al. [2014] stated that selection of mink for large body size may lead to obesity and, in consequence, to a poor reproduction results. This was previously demonstrated by Tinggaard et al. [2012], who observed that obese females gave birth to poorer litters,

lidia.felska-blaszczyk@zut.edu.pl

compared to those in the ideal body condition, despite the same number of placental scars indicating embryonic implantations. Similar observations were reported by Lagerkvist et al. [1994], who found that females selected for large body size produced smaller litters with a higher offspring mortality, and their coat was of poorer quality compared to that of smaller females. According to Rouvinen-Watt [2003], female mink that exhibit an abnormal body condition before breeding are predisposed to lactation anemia that occur in pregnancy and offspring nursing.

There is a linkage between body condition and stereotypy. Jeppesen et al. [2004] found that females showing a higher incidence of stereotypic behaviors were smaller in size, livelier and gave birth to larger litters of kits that weaned better. The authors reported that better reproduction performance achieved by such females may be a result of their better response to the full-ration, high-energy feeding regimen starting 4–5 days prior to mating (flush feeding) and that is why the females exhibit better physical condition. Our previous another studies reported that studies [Felska-Błaszczyk et al. 2017] showed that body condition of males had no effect on the number of matings, although it significantly altered the animals' behavior during the breeding season, especially if we look at the aggressive behavior of males against females, and fur-chewing. The highest number of aggression incidents was observed in males of a very thin to ideal body condition, whereas – in contrast – about half of these behaviors happened among obese mink males. Males which were either very thin or obese exhibited the fur-chewing stereotype, which was otherwise absent among males of a thin and ideal body condition.

The aim of this study was to evaluate the impact of the body condition of breeding females on their reproduction performance and their behavior in pregnancy and during lactation.

MATERIAL AND METHODS

This study was carried out in strict accordance with the recommendations of the Polish Act dated 21 January 2005 on Animal Experiments (Journal of Laws 2005, no. 33, pos. 289). The protocol was approved by the Local Ethical Committee for Experiments on Animals at the West Pomeranian University of Technology, Szczecin, Poland (permit number: 10/2015, dated 15 May 2015). The study was carried out on a commercial mink farm located in the north-western part of Poland. Females of Perl mink (n = 601) at age 1 (311 females) and 2 years (290 females) were housed in standard mink cages and fed a feed composed according to generally accepted standards [PAN 2011]. Supplied by an independent producer, the semi-liquid feed was based on chicken and fish. The feed was provided 3 times using semi-automatic feeders, with a portion of feed being placed directly on top of the cage. All animals had equal access to both drinking water and food.

All the data for the study were obtained through uninvasive, contactless observations carried out during normal farm operations. Shortly (4–5 days) before mating, a mink evaluation expert rated the body condition of each animal on the 5-point scale, and the females were accordingly assigned to the following groups [Hynes et al. 2004, Møller et al. 2015]:

- Group 1, very thin – an emaciated appearance with reduced muscle mass, a thin neck and a clearly V-shaped body; no body fat, the stomach sunk in, the shoulder and hip bones visible, ribs easily felt.
- Group 2, thin – a thin neck and a V-shaped waistline; no subcutaneous body fat layer; the shoulder bones, hip bones and the ribs easily felt.
- Group 3, ideal – a slender neck and a straight body shape; a slight amount of subcutaneous body fat; shoulder and hip bones and the ribs can be easily felt.
- Group 4, heavy – a thicker neck and a pear-shaped body, the ribs difficult to feel, the shoulder and hip bones covered by a moderate fat layer; an abdominal fat pad present.
- Group 5, obese – a thick neck and a full body shape, the ribs very difficult to feel, the shoulder and hip bones covered by a moderate to thick fat layer; a fat pad present in the abdomen and the tail; fat deposits visible in the limbs and the facial part of the head.

Condition group sizes are presented in Table 1. Matings took place in basically the same period, the first breeding was between 1 through 5 of March; females were mated 3 or 4 times.

Table 1. The number of mink groups used in the experiment in relation to their body condition

Tabela 1. Liczebność grup norek wykorzystanych w doświadczeniu w zależności od ich kondycji ciała

Age, years Wiek, lata	Body condition group – Grupy kondycyji ciała				
	1	2	3	4	5
1	53	78	67	54	59
2	57	50	61	69	53
Total – Razem	110	128	128	123	112

The following reproduction parameters and behavior types were analyzed:

- Gestation and diapause length (the length of the diapause equals total gestation period minus 36 days, i.e. 6 days of the embryo growth before diapause plus 30 days between implantation and birth).

– Litter size.
– Live-born kits per litter.
– Weaned kits per litter.
– Barren females percentage.
– Female mortality in pregnancy.
– Percentage of fur-chewing females.

The datasets were processed statistically using the STATISTICA 13.3 package. The statistical description involved the mean (m), standard deviation (SD), and the coefficient of variability (V%).

RESULTS AND DISCUSSION

Gestation and diapause length

As can be concluded from Table 2, there is a number of significant ($P \leq 0.01$ and $P \leq 0.05$) differences in the length of both diapause and gestation depending on the body condition. Significant ($P \leq 0.01$) differences were also found in relation to age; yearling females had a shorter diapause and gestation, as compared with two-year-old dams. Females of the condition group 1 in either age group featured the shortest diapause and gestation periods. On the other hand, the longest diapause and gestations were noted in group-5 yearling females and group-3 two-year-old ones.

The extreme values illustrate the wide range of length in both the diapause and, consequently, the gestation. There were yearling females which actually never entered diapause; this pertained to females of the condition groups 3 and 4, which also exhibited very long diapause periods (e.g. 58 days in group 3). Two-year-old females did not show such a high variation, which can be concluded from the coefficient of variability, higher in the yearling females compared to the adult age group.

The effect of body condition on female mink reproduction performance is more strongly pronounced in yearling females, which was also noted by Tauson [1993]. The shortest gestation lengths were observed in one-year-old females, both of the thinnest and the ideal-condition groups.

Litter sizes, number of live-born kits and weaned kits per litter

Body condition exerted a more pronounced influence on the analyzed parameters in one-year-old females; the largest litter sizes and the greatest numbers of live-born and weaned kits per litter were noted for females with the best body condition score (Table 3, group 3). There was no such association among two-year-old females, where the extreme litter parameters were observed in various condition groups. Higher values of these parameters were observed in yearling females. Boudreau et al. [2014] also report that females with lower body weight produce larger litters and nurse their offspring better (with lower kit mortality rates). Similar results were reported by Lagerkvist et al. [1994] and Tinggaard et al. [2012], who found that heavier females exhibited poorer reproduction performance. Baekgaard et al. [2006] and Clausen et al. [2006] observed smaller litters in females that were obese at the moment of parturition.

The long term selection process of farm mink has produced varieties with larger body sizes, with a consequence in their bodies being prone to excessive fat deposition [Boudreau et al. 2014]. Farmers should focus on the diet that will bring the animals to the ideal condition before every breeding season. Obesity control in mink will also reduce the risk of diabetes or fatty liver disease [Rouvinen-Watt 2003, Rouvinen-Watt et al. 2010]. Boudreau et al. [2014] noted that females that had been brought to ideal condition before breeding maintained that condition throughout lactation, and also recovered better during the period following it. The fact that body condition has been included as an evaluated parameter in the WelFur certification program [Mononen et al. 2012, Boudreau et al. 2014] shows, how important it is for the welfare of the animals.

Percentage of fur-chewing females, barrenness

Table 4 displays the percentage of females showing the stereotypical behavior in pregnancy, i.e. fur chewing. This undesirable effect was observed more frequently in the thinnest and the most obese females (condition groups 1 and 5), in both age groups; in two-year-old females, however, fur chewing was less frequent compared to yearling females. The highest number of barren females were among very thin animals (group 1), in both one- and two-year-old females, and among the obese females (group 5), which also pertained to both age groups. The lowest barrenness, on the other hand, was found among females in the ideal body condition (group 3). We found that the percentage of barren females was more than twice lower in the older females compared to the younger age group of females.

The results of our study also suggest that body condition is a factor in terms of stereotypical behaviors, such as fur-chewing studied here, since their highest incidence was noted in both the thinnest and most obese females (groups 1 and 5). Jeppesen et al. [2004] found that stereotypy-affected females were lighter in body weight, as compared with unaffected females, yet they were characteristic for a higher fertility, lower barrenness rates, larger litters and a lower pre-weaning mortality of the offspring. Similar pattern emerged in our previous analysis of mink body condition in relation to male mating behavior [Felska-Błaszczyk et al. 2017]. Namely, no fur-chewing was observed among ideal-condition males, which otherwise was very common in the groups of heavy and obese animals. On the contrary, the pattern

Table 2. Statistical description of diapause and gestation lengths in relation to age and body condition score

Table 2. Charakterystyka statystyczna diapauzy i długości ciąży w zależności od wieku i kondycji ciała

Item Cecha	Age, years Wiek, lata	Body condition score Kondycja ciała	Mean, days Średnia, dni	SD	V%	Min.	Max.
Diapause Diapauza	1	1	15.71^{Aabc}	6.02	38.34	5	45
		2	16.13^{def}	4.34	26.93	5	25
		3	15.90^{Bghi}	7.02	44.14	0	58
		4	16.25^{jkl}	4.79	29.47	0	25
		5	16.41^{1}	6.76	41.20	3	48
		Total – Razem	16.09**	5.81	36.11	0	58
	2	1	17.88	4.97	27.81	6	30
		2	18.72^{adgjl}	3.80	20.30	10	26
		3	19.14^{ABekl}	6.00	31.35	5	43
		4	18.33^{bh}	3.61	19.70	9	27
		5	18.50^{cfi}	4.33	23.39	9	29
		Total – Razem	18.52**	4.65	25.13	5	43
	Total diapause – Razem diapauza		17.27	5.42	31.36	0	58
Gestation length Długość ciąży	1	1	51.71^{Aabc}	6.02	11.65	41	81
		2	52.13^{def}	4.34	8.33	41	61
		3	51.90^{Bghi}	7.02	13.52	36	94
		4	52.25^{jkl}	4.79	9.17	36	61
		5	52.41^{1}	6.76	12.90	39	84
		Total – Razem	52.09**	5.81	11.15	36	94
	2	1	53.88	4.97	9.23	42	66
		2	54.72^{adgjl}	3.80	6.94	46	62
		3	55.14^{ABekl}	6.00	10.88	41	79
		4	54.33^{bh}	3.61	6.65	45	63
		5	54.50^{cfi}	4.33	7.94	45	65
		Total – Razem	54.52**	4.65	8.54	41	79
	Total gestation – Razem ciąża		53.27	5.42	10.17	36	94

A, B – differences within column significant at $P \leq 0.01$.
A, B – różnice w kolumnie istotne na poziomie $P \leq 0,01$.
a, b, c… – differences within column significant at $P \leq 0.05$.
a, b, c… – różnice w kolumnie istotne na poziomie $P \leq 0,05$.
** – differences between means within column depending on age significant at $P \leq 0.01$.
** – różnice między średnimi w kolumnie w zależności od wieku istotne na poziomie $P \leq 0,01$.

of aggressive behavior incidents was reversed; aggression was the most common among the thinnest males, but also those with ideal condition. About a half of such aggression incidents only happened among obese males. Mason [1993] suggests that stereotypic behaviors may be a result of increased appetite and are related to the natural foraging behavior; this may explain why obese animals, which obtain reduced rations before the mating season, exhibit abnormal behaviors. This idea was also supported by Malmkvist et al. [2013], who noted more cases of fur-chewing during the period of restricted feeding.

CONCLUSIONS

Body condition was of greater importance in relation to reproduction performance in yearling females, where the largest litters and highest rates of live-born and weaned per litter were recorded in females of ideal condition. In both age groups, the shortest diapause gestation periods were noted in the thinnest females, i.e. in group 1. The fur-chewing behavior was more often found in the extremes, the thinnest and obese females; these two groups also exhibited the highest barrenness rate. On the other

Table 3. Statistical characteristics of litter size, live-born per litter and weaned offspring per litter in relation to dam's age and body condition

Tabela 3. Charakterystyka statystyczna wielkości miotu, liczby żywo urodzonych młodych w miocie oraz odchowanych młodych w miocie w zależności od wieku i kondycji ciała

Item Cecha	Age, years Wiek, lata	Body condition score Kondycja ciała	Mean Średnia	SD	V%	Min.	Max.
Litter size Wielkość miotu	1	1	6.63	1.89	28.55	2	13
		2	6.37	1.90	29.90	2	11
		3	7.06^{ab}	1.63	23.05	2	10
		4	6.67	1.57	23.56	2	9
		5	6.57	1.96	29.87	2	11
		Total – Razem	6.66	1.80	27.00	2	13
	2	1	6.42	1.53	23.78	3	9
		2	6.63	1.91	28.89	2	11
		3	6.23^{a}	1.71	27.45	2	10
		4	6.20^{b}	1.66	26.86	2	10
		5	6.59	1.53	23.21	2	9
		Total – Razem	6.39	1.67	26.12	2	11
	Total litter size – Razem wielkość miotu		6.53	1.74	26.66	2	13
Live-born per litter Żywo urodzone młode w miocie	1	1	6.32	1.97	31.15	2	13
		2	6.31	1.90	30.10	2	11
		3	6.81^{abc}	1.50	22.07	2	10
		4	6.49	1.53	23.54	2	9
		5	6.27	1.70	27.06	2	10
		Total – Razem	6.45	1.72	26.68	2	13
	2	1	6.20	1.46	23.50	3	9
		2	6.16	2.07	33.58	0	11
		3	5.93^{c}	1.54	25.94	2	8
		4	5.98^{a}	1.59	26.56	2	10
		5	6.34^{b}	1.52	24.04	2	9
		Total – Razem	6.10	1.63	26.66	0	11
	Total live-born – Razem żywo urodzone		6.28	1.68	26.80	0	13
Weaned per litter Odchowane z miotu	1	1	5.76	1.61	27.95	2	9
		2	5.97	1.70	28.56	2	8
		3	6.31	1.43	22.71	2	8
		4	6.12	1.39	22.80	2	9
		5	5.74	1.51	26.25	2	8
		Total – Razem	6.00	1.54	25.69	2	8
	2	1	5.84	1.43	24.55	3	8
		2	5.88	1.81	30.85	0	8
		3	5.72	1.64	28.64	2	8
		4	5.62	1.57	28.02	2	8
		5	6.00	1.54	25.67	2	9
		Total – Razem	5.79	1.59	27.50	0	9
	Total weaned – Razem odchowane		5.90	1.57	26.59	0	9

a, b – differences within column significant at $P \leq 0.05$. a, b – Różnice w kolumnie istotne na poziomie $P \leq 0,05$.

Table 4. The percentAge, years of fur-chewing females, and barren females in relation to age and body condition

Tabela 4. Procent samic gryzących futro i jałowych w zależności od wieku i kondycji ciała

Age, years Wiek, lata	Body condition score Kondycja ciała	Percentage of females, % – Procent samic, %	
		fur-chewing – gryzących futro	barren – jałowych
1	1	3.85	18.52
	2	1.85	7.69
	3	0.00	5.56
	4	0.00	5.97
	5	1.69	10.17
	Total – Razem	1.61	9.32
2	1	1.64	13.21
	2	0.00	5.26
	3	0.00	0.00
	4	0.00	2.90
	5	1.89	8.00
	Total – Razem	0.69	3.45
Total age – Razem wiek		1.16	7.49

hand, animals of ideal condition had the lowest percentage of fur-chewing behaviors and barrenness. These results suggest that both obesity and emaciation should be avoided in the breeding stock. Both adequate body condition evaluation and application of appropriate feeding will help to accomplish this task.

ACKNOWLEDGEMENTS

The Authors wish to thank Mr Maciej Buczek for his kind permition to carry out the observations on his farm, and Małgorzata Dziadosz-Styś, PhD, a professional mink selection expert, for scoring the condition of the animals. We also thank Piotr Błaszczyk, PhD, for his scholarly translation of the manuscript into English.

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WPŁYW KONDYCJI CIAŁA SAMIC NORKI (*NEOVISON VISON*) NA WSKAŹNIKI ROZRODU I ZACHOWANIE W OKRESIE CIĄŻY I ODCHOWU MŁODYCH

STRESZCZENIE

Badanie miało na celu ocenę wpływu kondycji ciała samic norek hodowlanych (*Neovison vison*) w momencie zapłodnienia na ich rozmnażanie i zachowanie. Populację 601 samic norek odmiany perła, rocznych i w wieku 2 lat, podzielono na 5 grup, zgodnie z kondycją ciała. Przeanalizowano następujące parametry: długość ciąży i długość diapauzy, wielkość miotu, liczbę żywo urodzonych młodych w miocie, liczbę odsadzonych młodych z miotu, procent samic jałowych i występowanie zjawiska gryzienia futra (*fur-chewing*). Wpływ kondycji ciała był bardziej wyraźny u samic rocznych, u których największe mioty, największą liczbę żywo urodzonych młodych w miocie i największą liczbę odsadzonych młodych stwierdzono w grupie o idealnej kondycji ciała. W obu grupach wiekowych najkrótsze ciąże i okresy diapauzy obserwowano u najchudszych samic. Gryzienie futra było najczęściej zauważane u najchudszych i najbardziej otyłych zwierząt; samice z tych grup również wykazywały najwyższe wskaźniki jałowości. Najmniejszy procent samic, które wygryzały futro, i najmniejszy procent samic jałowych stwierdzono u zwierząt z idealną kondycją ciała.

Słowa kluczowe: norka, kondycja ciała, behawior, rozród, krycie

Lidia Felska-Błaszczyk https://orcid.org/0000-0002-3765-5954
Beata Seremak https://orcid.org/0000-0003-0917-0607