

## Modeling the Effect of Lameness on Culling of Dairy Cows in Tehran Province

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### Abstract

**Objective-**To assess the effect of lameness on culling of dairy cows in Tehran province.

**Design-** Historical cohort study.

**Study population and procedures-** 7067 first- and second-parity Holstein dairy cows that calved from March, 21 2007 to March, 20 2008 were until next calving or culling. Logistic regression was conducted data.

**Results-**The overall lactational culling rate for eligible cows in the study was 22.09% (95% CI: 19.26-24.9%). Lameness was an important factor in the model and increased odds of culling (OR= 1.32; 95% Confidence interval = 1.15-1.51). Moreover, parity, 60-day cumulative milk yield, and herd size increased culling odds. We did not find evidence for a significant effect of calving season on culling.

**Conclusion-** Lameness is an important factor in culling decision in dairy herds in this area.

**Keywords:** culling, dairy cow, logistic regression, Tehran province.

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## Introduction

Culling in dairy cows is not only complex, but also expensive and challenging.<sup>1</sup> Culling is a technique to improve the herd; however, incorrect timing of culling might lead to a suboptimal use of limited replacement resources. Replacement costs are considered as being the second, after feed costs, largest expense for the dairy enterprises. Both biological and managerial factors can affect the culling decision in general. When making a decision, the dairy farmer may consider several major aspects such as illness, milk yield status, conception status, availability of replacements, stage of lactation, and parity.<sup>2-3</sup> In other words, the decision to remove a cow from the herd is mainly based on economic considerations and the farmer expects to secure more profit by replacing a cow.<sup>4-5</sup>

A number of diseases play a role in culling decision and lameness may be one of the most important ones. Lameness is a prevalent disease that affects milk production and reproduction performance.<sup>6</sup> Lameness compromises the welfare of affected animals severely and may be the most frequent cause of distress in dairy cattle.<sup>7</sup> Therefore, the ultimate cost of a case of lameness is substantially greater than treatment costs alone. For example, the overall cost of lameness is predicted to be £246.22 per case in the United Kingdom.<sup>7-9</sup> Although several studies have evaluated the relationship between lameness and culling risk, this effect is a matter of controversy. Studies have shown that the risk of being culled is increased<sup>6-7,10-11</sup>, decreased<sup>12</sup>, or not affected by lameness or the presence of foot lesions.<sup>13-14</sup>

Although the effects of lameness on culling have been investigated in several countries<sup>15-16</sup>, there is an absence of relevant studies in Iran. Factors identified in other countries can be used as indicators but cannot be directly extrapolated to Iran due to possible managerial and industrial differences. In the present study, we conducted a historical cohort study with logistic regression analysis to assess the effect of lameness on the odds of culling in dairy herds in Tehran province.

## Materials and Methods

### *Study population and data collection*

We gathered data from 32 randomly selected commercial dairy herds located in Tehran province. Commercial dairy herds in this area are predominately comprised of Holstein-Friesian cattle that calve throughout the year and re-breed using artificial insemination. Cows are housed in open-shed barns and milked 2 or 3 times a day. Herds are fed on total mixed rations; diets are based primarily on corn silage, alfalfa hay and concentrates including corn, soya meal, bone meal and mineral supplements.<sup>17-18</sup>

Only herds with >50 cows and under continuous veterinary supervision (at least one veterinarian visiting as full or part time) were selected. In these herds, only first- and second-parity cows, which calved between March, 21<sup>st</sup> 2007 and March, 20<sup>th</sup> 2008 (beginning of the Persian year) were followed up until next calving or culling.

We collected individual animal records on lameness occurrence, productive and reproductive performance. In addition to lameness, we also included several potential confounders (herd size, calving season, parity and a 60-day cumulative milk yield). Herd size was divided in 2 classes:  $\leq 500$  cows and  $> 500$  cows in herd. Calving season classes were created (spring: March 21<sup>st</sup> to June 20<sup>th</sup>, summer: June 21<sup>st</sup> to September 20<sup>th</sup>, fall:

September 21<sup>th</sup> to December 20<sup>th</sup> and winter: December 21<sup>th</sup> to March 20<sup>th</sup>). Milk classes were chosen as >2100 liter, 1801 to 2100 liter, 1501 to 1800 liter and ≤1500 liter. We only considered the inclusion of data on first- and second-parity cows because we were interested in the impact of health disorders on premature culling.<sup>8</sup> In addition, the distribution of cows in the first and second lactation accounted for about two-thirds of the animals in each herd.<sup>19</sup> Although pregnancy status is also an important factor in culling decisions, we did not include it in the model due to its role as an intervening variable in the disease-culling association.<sup>7,20</sup>

### *Statistical Analysis*

We utilized logistic regression model through a three-stage model building approach, in order to assess the effect of lameness and other parameters on the odds of culling. The dependent variable was culling status. In the first stage, correlation analysis of independent variables was conducted to identify pairs of variables that essentially contained the same information and had to be removed due to collinearity. In the second stage, univariable analysis was carried to identify variables that were associated with time to culling. During this screening phase, a significance level of 0.20 was used. In the third stage, all variables with  $P < 0.20$  were simultaneously offered to a full model which was subsequently, reduced by backwards elimination. The reduced model was compared to the full model by means of the likelihood ratio test. The procedure was repeated until all the remaining variables were significant at  $P \leq 0.05$ . Finally, a stepwise forward selection process was done by offering previously excluded variables to the final model one at a time and retained if significant.<sup>21</sup> Data management and analysis were performed using Stata statistical software (StataCorp. 2007. Stata Statistical Software: Release 10.1 College Station, TX: StataCorp LP.).

### **Results**

A total of 7067 cows were included in the analysis. Twenty one out of the 32 herds (65.6%) had a herd size ≤ 500, while 11 (34.4%) had a herd size > 500 cows. The corresponding number of cows was 1459 cows (20.7%) and 5608 cows (79.3%) in each herd category. Overall, there were 3904 (56.4%) and 3163 (43.6%) first and second lactation cows, respectively.

In total, 22.09% (95% CI: 19.26-24.9%) cows were culled during the study; culling in first- and second-parity was 18.4% (95% CI: 16.02-20.82%) and 26.58% (95% CI: 23.16-29.99%), respectively.

Table 1 summarizes the data analyzed in the study. Higher parity cows had a higher risk of culling. Cows reared in large size herds were at a higher risk of being culled compared to those in small size herds. The risk of culling increased with decreasing milk production. What is more, we did not find any evidence for a significant effect of calving season on culling.

**Table 1:** Estimated Odds ratio (OR) and 95% confidence intervals (CIs) for the effect of lameness on culling, under a logistic regression. Estimations were based on data of 7067 Iranian dairy cows reared in 32 dairy herds that calved between 21<sup>st</sup> March 2007 and 20<sup>th</sup> March 2008

Variable	OR	CIs	p-value
<b>Parity</b>			
1	1	-	-
2	1.48	1.32- 1.67	<0.001
<b>60-d cumulative milk yield</b>			
>2100 lit.	1	-	-
1801-2100 lit.	2.61	1.97-3.47	<0.001
1501-1800 lit.	5.98	4.48-7.98	<0.001
≤1500 lit.	8.09	6.1-10.7	<0.001
<b>Herd size</b>			
≤500	1	-	-
>500	1.52	1.3-1.77	<0.001
<b>Lameness</b>			
No	1	-	-
Yes	1.32	1.15-1.51	<0.001

## Discussion

We employed a logistic regression model to investigate the effect of lameness on the hazard of culling in dairy cows in Tehran province. We realized that lameness is an important factor on culling decision in this area.

A critical step in study design and subsequent model development was the identification of potential intervening and confounding variables.<sup>6,21</sup> The role of health disorders as possible risk factors for culling was sometimes investigated without considering any other individual criterion.<sup>22</sup> In most studies, however, other individual characteristics of a cow were included in the analysis. These characteristics were analyzed as main effect or confounders with the hypothesis that they may be related both to diseases and to culling. In this way, different variables may be considered as relevant.<sup>23</sup> On these grounds, we have excluded pregnancy status from the analysis. Other studies considered pregnancy status to be a confounder<sup>4,24</sup> or an intervening variable.<sup>7,11,20,25</sup> Milk yield could also be considered as an intervening variable.<sup>26</sup> However, we preferred to treat milk yield as a potential confounder and also included a 60-day cumulative individual milk yield in the analysis. This milk productivity index is known to better express the productivity potential of a cow and is less affected by the occurrence of most health disorders.<sup>1,27</sup> Moreover, use of the 60-day milk yield had the benefit of including more time to culling observations in the analysis without loss of information on the productivity potential compared to more general milk yield indices such as the 305-day cumulative milk yield.<sup>28</sup> Additionally, we considered herd size, calving season and parity as potential confounders.

As expected, the odds of culling increased noticeably with parity. Dairy cows have age dependent risk of being culled. The end of the first lactation represents a major decision point with respect to culling. Culling risk for other diseases and injuries also increase with age.<sup>29</sup> Moreover, age and parity were associated with an increase in risk of health disorders.<sup>23</sup> As expected decreased milk production increased culling odds<sup>2,7,24</sup>, while calving season had no effect on culling.<sup>2,30</sup> At least 20% of the culled dairy cows are eliminated for low milk production.<sup>23</sup> Further, herds of smaller size posed a lower risk of culling, which is probably due to the lack of available replacement heifers and, thus, the need to expand the productive life of existing cows. The latter could also be ascribed to the herd owners' wish to expand the capacity of their dairies.<sup>31</sup> Several reasons may lead to

include a herd effect in the analysis. Cows in different herds with identical individual risk factors may not have the same probability of culling.<sup>23</sup> Individual culling decisions may be highly dependent on the specific environment of the herd. Furthermore, culling of a particular cow may not only depend on her own characteristics but also on the characteristics of the other cows in the herd and on events occurring at the herd level.<sup>23</sup> Within-herd characteristics (availability of heifers, farmer's attitude towards risk and uncertainty, milk and beef market...) modify the risk for a cow to be culled for a given health disorder.<sup>1</sup>

Lameness was associated with culling. In accordance with previous reports, we found a positive association between lameness and culling<sup>6-7,10,22</sup> while few authors have reported no association between lameness and culling.<sup>13,32</sup> It should be taken into account that the term "feet and leg problems" was not defined consistently and included many different types of afflictions, which made it difficult to relate specific disorders to culling. This generalization could contribute to the discrepancies found in the literature.<sup>29</sup>

Several aspects should be kept in mind when comparing the results of different studies. The statistical methods used vary among studies as do the model variables; the inclusion of mediating factors, such as milk yield and reproductive performance, can alter the magnitude of the effect of some diseases on culling. Definition of diseases may also vary among studies as well as the number of observations analyzed. The exclusion of particular cows from the analysis (e.g., those with missing milk records) may alter the effect of some diseases on culling. Target populations and breeds of cows vary among studies.<sup>2</sup>

## Conclusions and recommendations

The results of this study show lameness is an important factor on culling in Iranian dairy cows and factors relating to lameness management must be improved in Iranian dairy herds to increase reproductive performance and reduce the risk of culling.

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## بررسی مدل آماری اثر لنگش بر حذف گاوهای شیری در گاوداری های استان تهران

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**هدف-** بررسی اثر لنگش بر روی حذف گاوهای شیری در گاوداری های استان تهران.  
**طرح مطالعه-** مطالعه همگروهی تاریخی.

**جمعیت مطالعه و روش کار-** ۷۰۶۷ گاو شیری نژاد هلشتاین که در فاصله ۱۳۸۶/۱/۱ تا ۱۳۸۶/۱۲/۲۹ زایش داشتند. این گاوها تا زایش بعدی یا حذف مورد مطالعه قرار گرفتند. رگرسیون لجستیک جهت آنالیز داده ها به کار گرفته شد.  
**نتایج-** میزان حذف کلی در یک دوره شیردهی جهت گاوهای مورد مطالعه ۲۲/۰۹ درصد (فاصله اطمینان ۹۵ درصد: ۲۴/۹-۱۹/۲۶) به دست آمد. لنگش یک فاکتور مهم در مدل فوق بود و شانس حذف را ۱/۳۲ (با دامنه اطمینان ۹۵٪)؛ ۱/۵۱-۱/۱۵) برابر افزایش داد. به علاوه، شکم زایش، میزان تولید شیر ۶۰ روزه و اندازه گله شانس حذف را افزایش دادند. اما رابطه معنی داری بین فصل زایش و حذف پیدا نشد.  
**نتیجه گیری-** لنگش فاکتور مهمی در تصمیم گیری جهت حذف در گله های گاو شیری در این منطقه می باشد.  
**کلید واژگان-** حذف، گاو شیری، رگرسیون لجستیک، استان تهران.