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THE EFFECT OF AGE OF COWS ON VARIABILITY IN MASTITIS PREVALENCE RISK AND ITS CONCOMITANT IMPACTS ON THE SUCCESSIVE DAILY MILK YIELD

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OPEN ACCESS

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SUMMARY

The purpose of this study is to determine the effect of age of cows on variability in mastitis prevalence risk and its concomitant impacts on their successive daily milk yield by analyzing test-day records of dairy cows collected in the period 2005–2022. The results obtained indicate a correlation between the age and breed of cows enrolled in the study and mastitis prevalence risk alongside its concomitant impacts on their successive daily milk yield. The findings demonstrate a progressive increase in mastitis prevalence risk with the advancing age of cows, notably more pronounced in the Holstein breed than in the Simmental breed. The Simmental cows exhibited a lower increase in daily milk yield, experiencing a substantial decrease in overall yields (namely milk, fat, and protein) in contrast to the Holstein cows. The primiparous cows of both breeds displayed the highest total increase in daily milk yield. This study underscores the significance of monitoring dairy herd health as a pivotal component of successful dairy herd management. Moreover, the daily lactose content was found a valuable and cost-effective indicator for ensuring the economically and environmentally sustainable operations of dairy farms.

Key words:
milk yield, fat and protein yield, daily lactose content, mastitis prevalence risk, dairy cattle

Abbreviations:
DMY – daily milk yield; DFY – daily fat yield; DPY – daily protein yield; DCL – daily lactose content

INTRODUCTION

Mastitis (the inflammation of the udder) is considered one of the most prevalent and costly disorders in dairy cows. It prompts various udder changes (swelling, warmness, redness, pain, necrosis, etc.), ultimately reducing milk production and weakening the animals. Mastitis prevalence arises from diverse factors including bacterial infections (*Staphylococcus aureus*, *Streptococcus species*, *Escherichia coli*, etc.), non-infectious causes (mechanical injury, irritation, hormonal imbalances, etc.), and environmental triggers (poor hygiene, unsanitary or damp bedding, inadequate milking).
This condition manifests in clinical or subclinical forms, necessitating increased antibiotic use that potentially results in resistance to the causative agent (Ebrahimi et al., 2019). Furthermore, both states of mastitis (clinical and subclinical) are associated with significant financial losses for dairy farms due to decreased milk quality and production (Halasa et al., 2007). Özkan Gülzari et al. (2018) highlighted the adverse environmental impact of mastitis, advocating early detection, prevention, and management of subclinical mastitis to curtail greenhouse gas

emissions per kilogram of produced milk on dairy farms. Therefore, the development of efficient dairy herd monitoring methods and preventative measures against mastitis prevalence becomes imperative for economically and environmentally sustainable dairy farming. Pyorala (2003) suggested using the daily lactose content as a viable indicator of mastitis prevalence. Silanikove et al. (2014) underscored that mammary gland inflammation leads to cell damage and reduced lactose synthesis, consequently lowering lactose content in milk. Babnik et al. (2004) specified that a daily lactose content below 4.5% indicates a risk of mastitis prevalence.

As mastitis poses one of the major issues on dairy cattle farms, this study aims to assess the effect of age of cows on variability in mastitis prevalence risk and its concomitant impacts on the fat, protein and successive daily milk yields in Simmental and Holstein cows.

MATERIAL AND METHODS

This study utilized the test-day records of Simmental and Holstein dairy cows, collected during the routine milk recording in Croatia spanning from January 2005 to December 2022. The milk recording in Croatia involves employing the alternative milk recording method every four weeks (AT4/BT4). The milk sample analyses were conducted at the Central Laboratory for Milk Quality Control of the Croatian Agency for Agriculture and Food, using proper equipment and contemporary methods such as the Milcoscan FT6000 and infrared spectrophotometry for milk component determination. Following the logical verification of milk recording data in accordance with the ICAR standards (ICAR, 2017) and rectifying non-logical variable values, the refined dataset comprised 4,922,751 test-day records of Simmental cows and 3,953,637 test-day records of Holstein cows. The definition of mastitis prevalence risk relied on using the daily lactose content (DLC), where DLC $\geq$ 4.5% indicated healthy animals, whereas DLC < 4.5% suggested a risk of mastitis prevalence. The mastitis prevalence risk was computed as the percentage (%) of cows at risk within the total dairy cattle population, calculated separately for each breed. Furthermore, the investigation into the impact of mastitis prevalence risk on daily milk yield during successive milk recordings exclusively involved cows identified with a confirmed mastitis risk (DLC < 4.5%). The daily milk yield at the time of determining the mastitis prevalence risk was considered the reference value. A mastitis index was developed for categorizing the days after the confirmed risk into the following segments: D–0 (data at milk recording when the mastitis risk was determined), A–1 (within 35 days), A–2 (36–70 days), A–3 (71–105 days), and A–4 (> 105 days). The statistical model employed to assess the effect of mastitis prevalence risk on the daily milk yield incorporated fixed effects such as the lactation stage, age at first calving, milk recording season, herd size, and mastitis index. Statistical analyses were conducted separately for each parity class of cows (I, II, III, and IV +). The Scheffe's method of multiple comparisons within the MIXED procedure of SAS (SAS Institute Inc., 2019) was used for evaluating the significance of differences between the estimated least square means (LSMs). The estimated differences in daily milk yield (kg), during successive milk recordings subsequent to the occurrence of mastitis prevalence risk, were analyzed according to the age of cows within each parity class.

RESULTS AND DISCUSSION

Figure 1 illustrates the prevalence of healthy cows and those at risk of mastitis across different age-based parity classes (I, II, III, and IV+) within the Simmental breed. The results obtained reveal a significant influence of cow's age on mastitis prevalence risk. The study found that the highest percentage of cows at mastitis risk (DLC < 4.5%) was identified in cows within the fourth and higher lactation group (IV +: 56.6%). Conversely, the lowest prevalence risk was observed in the youngest cows (30.7%), indicating the highest percentage of healthy animals within the first lactation group.

Figure 2 depicts the prevalence of healthy cows and those at risk of mastitis across different age-based parity classes (I, II, III, and IV +) within the Holstein breed. Notably, the highest percentage of healthy animals, comprising 68.3%, was found within the first lactation group. Conversely, the highest percentage of animals at risk of mastitis was observed among cows in the IV + lactation group, reaching 61.4%. Moreover, a discernible trend emerges, showcasing an incremental increase in mastitis prevalence risk corresponding to the age of the animal. In essence, as the animal's age increases, so does the risk of mastitis prevalence. This trend of heightened mastitis prevalence risk with increasing animal age was evident in both breeds. However, it is noteworthy that a consistently higher risk was observed in the Holstein breed across all parity classes compared to the Simmental breed.

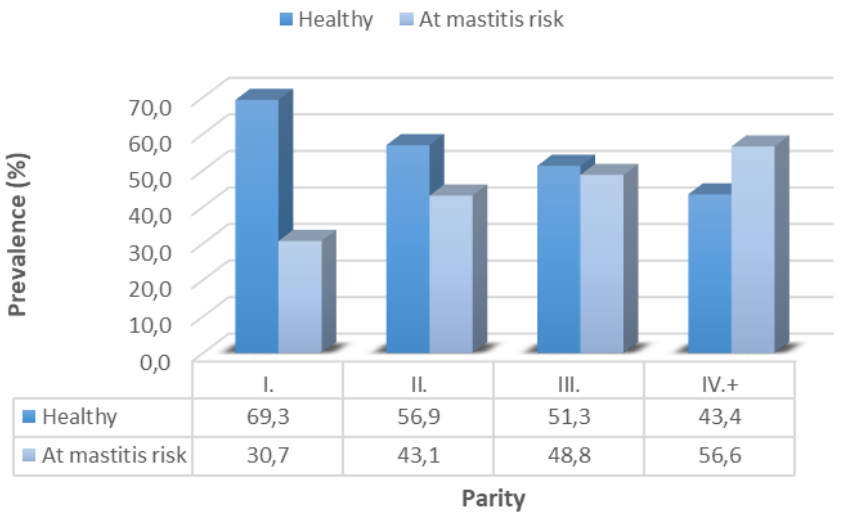

Figure 1. Prevalence of healthy Simmental cows and those at risk of mastitis across different age-based parity classes

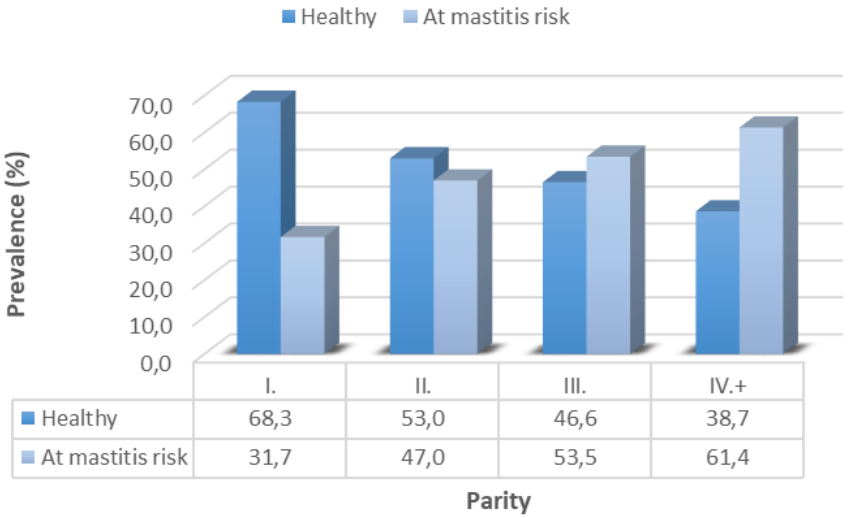

Figure 2. Prevalence of healthy Holstein cows and those at risk of mastitis across different age-based parity classes

Table 1 presents the estimated differences in daily milk, fat, and protein yield (kg) during successive milk recordings subsequent to determining the mastitis prevalence risk (DLC < 4.5%) in the Simmental cows considered. The Simmental cows exhibited an initial increase in daily milk yield after the first control following the identification of mastitis risk. The increase ranged from 6.80 kg/day (in the IV + parity cows) to 7.71 kg/day (in the III parity cows). However, during the first milk recording, the daily fat yield experienced a decrease ranging from 0.50 kg/day to 0.71 kg/day, whereas the daily protein yield generally increased, except for the first parity cows which experienced a slight drop of 0.009 kg/day. The most significant rise in daily milk yield, indicating a faster recovery of the animals, was observed in the third parity cows. Conversely, the oldest animals, i.e. the IV + parity cows, exhibited the lowest capacity to regain productivity in line with the genetic potential of healthy animals. During the following successive milk recordings, daily milk yields predominantly decreased, with the most substantial total loss observed in cows within the IV + lactation group (-1.97 kg/day), whereas the highest total loss in daily fat and protein yield occurred in the cows in the second lactation group (-0.92 kg/day; -0.45 kg/day, respectively).

Table 1. Estimated differences in daily milk, fat, and protein yields (kg) during successive milk recordings subsequent to determining the mastitis prevalence risk in Simmental cows across different age-based parity classes

Parity	I milk recording			II milk recording			III milk recording			IV milk recording			Total		
Trait	**DMY**	**DFY**	**DPY**	**DMY**	**DFY**	**DPY**	**DMY**	**DFY**	**DPY**	**DMY**	**DFY**	**DPY**	**DMY**	**DFY**	**DPY**
I	7.17	-0.71	-0.09	-0.81	0.02	-0.05	-1.59	-0.10	-0.06	-0.67	-0.06	-0.12	4.10	-0.86	-0.32
II	6.94	-0.62	0.00	-3.46	-0.07	-0.16	-2.39	-0.16	-0.11	-2.06	-0.07	-0.18	-0.97	-0.92	-0.45
III	7.71	-0.62	0.02	-2.44	0.03	-0.10	-3.88	-0.20	-0.14	-2.64	-0.11	-0.18	-1.26	-0.90	-0.40
IV +	6.80	-0.50	0.03	-3.40	-0.10	-0.12	-2.06	-0.13	-0.08	-3.31	-0.11	-0.17	-1.97	-0.83	-0.35

Legend: DMY – daily milk yield (kg); DFY – daily fat yield (kg); DPY – daily protein yield (kg)

Table 2 shows the estimated differences in daily milk, fat, and protein yields (kg) observed during successive milk recordings subsequent to determining the mastitis prevalence risk in the Holstein cows considered. Comparable to the Simmental cows, the Holstein cows exhibited an increase in daily milk yield during the initial successive milk recording. This increase ranged from 16.09 kg/day in the first parity cows to 22.60 kg/day in the third parity cows. Concurrently, the Holstein cows experienced a decrease in daily fat yield, ranging from 0.38 kg/day to 1.02 kg/day, alongside an increase in daily protein yield, ranging from 0.26 kg/day to 0.41 kg/day. Notably, the first parity cows demonstrated the lowest increase in milk and protein yield and the highest decrease in fat yield compared to other parity groups.

Table 2. Estimated differences in daily milk, fat, and protein yields (kg) during successive milk recordings subsequent to determining the mastitis prevalence risk in Holstein cows across different age-based parity classes

Parity	I milk recording			II milk recording			III milk recording			IV milk recording			Total		
Trait	**DMY**	**DFY**	**DPY**	**DMY**	**DFY**	**DPY**	**DMY**	**DFY**	**DPY**	**DMY**	**DFY**	**DPY**	**DMY**	**DFY**	**DPY**
I	16.09	-1.02	0.26	3.53	0.18	0.08	0.74	0.02	0.03	7.56	0.17	0.10	27.91	-0.66	0.47
II	20.70	-0.89	0.39	2.23	0.22	0.05	-0.91	-0.09	-0.06	5.76	0.23	0.02	27.78	-0.52	0.39
III	22.60	-0.64	0.41	-0.73	0.12	-0.03	-1.83	-0.02	-0.09	3.30	-0.03	-0.08	23.34	-0.58	0.21
IV +	21.11	-0.38	0.36	-4.24	-0.07	-0.15	-5.57	-0.17	-0.20	-1.26	-0.13	-0.23	10.04	-0.76	-0.21

Legend: DMY – daily milk yield (kg); DFY – daily fat yield (kg); DPY – daily protein yield (kg)

At subsequent milk recordings, the youngest cows of the first lactation group consistently demonstrated increased daily milk yield, resulting in the highest estimated difference at the end of the study period (namely 27.91 kg of milk and 0.47 kg of protein). In contrast, the oldest animals of the fourth plus (IV +) lactation group exhibited the lowest increase of 10.04 kg of milk with a simultaneous decrease in both fat and protein yields. Although the recovery from mastitis risk appeared faster in the older Holstein cows, the initial increase was not sustained. Conversely, the younger Holsteins exhibited a slower yet constant rise in milk production, culminating in the highest overall increase.

Previous studies by Tomazi et al. (2018), Gantner et al. (2011), and Weber et al. (2020) have highlighted factors such as season, herd size, husbandry system, average production, and somatic cell counts as potential contributors to the prevalence of clinical mastitis cases in dairy herds. Nóbrega & Langoni (2011) emphasized the significance of lactose content in milk as an indicator of mammary gland health. Costa et al. (2019) reported a correlation between the lactose content and animal health, noting that cows with DLC $\leq$ 4.553% exhibited higher health impairment compared to those with DLC $\geq$ 5.045%. The results obtained in this study indicate variability in mastitis prevalence risk relative to the age and breed of dairy cows with an aim of elucidating its concomitant impacts on their successive daily milk yield. Valdrina et al. (2014) affirmed that cows in higher lactation stages experience greater milk production loss. In like fashion, Atasever & Erdem (2008) found that milk production losses escalate with increasing lactation numbers.

CONCLUSION

The results obtained herein highlight significant variability in mastitis prevalence risk and its concomitant impacts according to the age and breed of dairy cows. Mastitis prevalence risk increased with the animal's age and was notably higher in the Holstein breed than in the Simmental breed. Additionally, the Simmental cows exhibited a lesser increase in daily milk yield, experiencing an overall decline in most yields (milk, fat, and protein) compared to the Holstein breed. Among both breeds, primiparous cows demonstrated the highest total increase in daily milk yield. In summary, monitoring dairy herd health emerges as a crucial element for successful dairy herd management. The

daily lactose content was identified as a valuable and cost-effective indicator for ensuring the economically and environmentally sustainable operations of dairy farms.

Conflict of interest: The authors declare that they have no conflict of interest.

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