



## The surveillance programme for small ruminant lentivirus infections in sheep and goats in Norway 2023

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# Content

|                                    |          |
|------------------------------------|----------|
| <b>Summary</b> .....               | <b>3</b> |
| <b>Introduction</b> .....          | <b>3</b> |
| <b>Aims</b> .....                  | <b>4</b> |
| <b>Materials and methods</b> ..... | <b>4</b> |
| <b>Results</b> .....               | <b>5</b> |
| Sheep .....                        | 5        |
| Goat .....                         | 6        |
| <b>Discussion</b> .....            | <b>7</b> |
| <b>References</b> .....            | <b>8</b> |

## Summary

None of the 3,258 investigated sheep flocks in the surveillance programme were diagnosed with maedi in 2023. Of 27 tested goat herds, none were diagnosed with caprine arthritis-encephalitis (CAE).

## Introduction

Small ruminant lentivirus (SRLV) comprise the maedi-visna virus (MVV) and the caprine arthritis-encephalitis virus (CAEV), which are closely related. Maedi-visna virus mainly infects sheep, while CAEV mainly infects goats, although cross-infections between the two species do occur.

Maedi is a progressive viral pneumonia in sheep first described in Iceland in 1939 (1). The disease occurs in several European countries as well as in other continents. The disease visna is a neuropathogenic manifestation of the infection (1, 2).

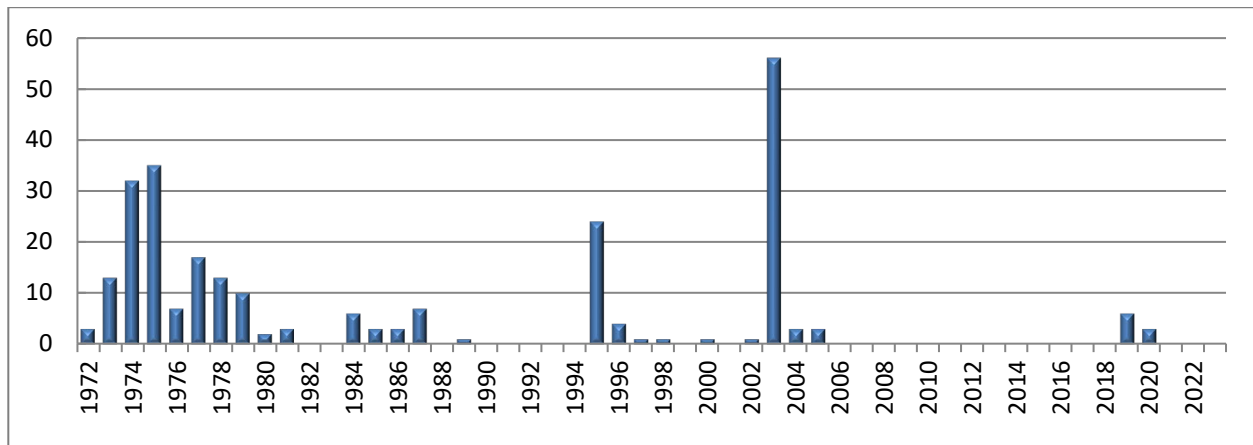
Caprine arthritis-encephalitis (CAE) causes emaciation, arthritis, encephalitis and sometimes mastitis and pneumonia in goats. Sheep may be infected and produce antibodies against CAEV, but usually show no clinical signs of disease.

Maedi-visna and CAE are classified as list 2 diseases in Norway and are notifiable to the World Organisation for Animal Health (WOAH). In Norway, maedi was officially reported for the first time in 1972 (3).

In November 2002 and January 2003, post-mortem examinations of lungs from two diseased sheep from two different farms in the former Nord-Trøndelag county showed histopathological changes consistent with maedi, and 61 flocks in the area were found to be seropositive. The outbreak demonstrated the need for a nationwide surveillance programme, and up to 2018 no new cases of maedi were detected (4-5).

In 2019, the surveillance programme detected a new case of maedi in a farm in Trøndelag county. Contacts to this farm were traced, and an outbreak zone was established in Northern Trøndelag, where all sheep farms were monitored by serology. In total, nine herds were diagnosed with maedi in this outbreak (5).

An overview of the number of new infected flocks registered with maedi each year up to and including 2023 is given in Figure 1.



**Figure 1:** The number of new flocks infected with maedi from 1972 and onwards. The bars for 2003 - 2005 show both seropositive flocks detected through the investigations after the outbreak in the former Nord-Trøndelag county (5), and seropositive flocks identified in the programme. The rise in 2019 to 2020 represents a new maedi outbreak in Trøndelag. The columns for 2003 and 2004 have been corrected after unpublished data about the 2002-2005 outbreak were discovered in 2023 (5).

Before 2001, CAE was widespread in the Norwegian dairy goat population. The dairy organisation (TINE) and the Norwegian Goat Health Services have conducted an eradication programme named “Healthier goats”, targeting caprine arthritis encephalitis, caseous lymphadenitis and paratuberculosis. The programme started in 2001, and in total 612 goat herds were included in the programme from 2001 to 2014 (6). In 2018, the goat population was included in the surveillance programme for SRLV.

The Norwegian Food Safety Authority (NFSA) is responsible for carrying out the programme. The samples are collected by inspectors from the NFSA, while the Norwegian Veterinary Institute (NVI) is in charge of planning the programme, performing the analyses and reporting the results.

## Aims

The aims of the surveillance programme for small ruminant lentivirus infections are to document the status for MVV and CAEV infections in sheep and goats in Norway and to identify infected flocks for disease control.

## Materials and methods

The surveillance programme is based on serological examination for SRLV in both sheep and goats.

The plan for 2023, was to collect 10,000 blood samples from sheep at slaughter. Representative numbers of animals were sampled at 20 larger abattoirs, from various parts of Norway. A maximum of five animals (>2.5 years old) were to be sampled per herd any given day. The preferred sampling period was from January to March, but a proportion of the animals was sampled from August to December. In addition, meat inspectors at the abattoirs were requested to monitor sheep carcasses, particularly the lungs, for suspicious lesions or findings consistent with maedi.

Of goat herds, 60 herds were randomly selected for sampling. In goat herds of less than 30 animals, all animals (>6 months old) were sampled. In herds of 30 to 100, 100 to 200, and more than 200 animals, samples from 30, 35, and 40 animals were collected, respectively. The preferred sampling period was from January to March, but a proportion of the animals were sampled from September to December. In addition, three goat herds that had submitted samples to NVI from abortions in 2022 were selected for blood sampling.

Serum samples were examined for antibodies against SRLV with ID Screen® MVV / CAEV Indirect ELISA (IDvet, Grabels, France, (hereafter referred to as IDvet ELISA)) for initial screening. Samples with positive or inconclusive ELISA results were re-tested in duplicates with IDvet ELISA. Samples that remained positive or inconclusive, were subsequently analysed in duplicates using the Elitest-MVV/CAE ELISA (Hyphen BioMed, Neuville sur Oise, France (hereafter referred to as Hyphen ELISA)).

In case of positive or inconclusive results in Hyphen ELISA on a sample taken from a sheep at slaughter, follow up sampling was done on selected animals in the flock of origin as described previously (7).

Samples with doubtful or positive status in confirmatory tests were reported, and new blood samples from the suspected animals or herd were requested and tested.

## Results

### Sheep

A total of 9,416 samples from 3,258 sheep flocks were included in the programme in 2023 (Table 1). This was approximately 25.0% of the total number of Norwegian sheep flocks.

Of the 9,416 samples, 9,354 (99.3%) tested negative in the IDvet ELISA, while 62 samples (0.7%) were positive or inconclusive. These were further tested with Hyphen ELISA, which gave negative results for 46, inconclusive for two, and positive results for 14 samples. Twelve of the 16 flocks with positive or inconclusive samples were followed up by sampling in the flock. All follow-up samples were negative. All these flocks were concluded to be seronegative for SRLV. The remaining four flocks had either been slaughtered or follow-up sampling was planned for 2024.

**Table 1:** The results and total number of sheep flocks tested for maedi within the frame of the Norwegian surveillance programme for SRLV 2003-2023.

| Year | Total no. of flocks* | No. of flocks analysed | No. of animals analysed | Average no. of animals analysed per flock | No. of positive flocks |
|------|----------------------|------------------------|-------------------------|---|------------------------|
| 2003 | 18 400               | 456**                  | 13 951                  | 30.6                                      | 1                      |
| 2004 | 17 439               | 1 230                  | 36 911                  | 30.0                                      | 1                      |
| 2005 | 16 500               | 940                    | 29 248                  | 31.1                                      | 2                      |
| 2006 | 15 800               | 911                    | 27 846                  | 30.6                                      | 0                      |
| 2007 | 15 400               | 1 004                  | 29 633                  | 29.5                                      | 0                      |
| 2008 | 15 059               | 783                    | 23 235                  | 29.7                                      | 0                      |
| 2009 | 14 800               | 417                    | 12 198                  | 29.3                                      | 0                      |
| 2010 | 14 800               | 188                    | 5 697                   | 60.6                                      | 0                      |
| 2011 | 14 500               | 467                    | 13 628                  | 29.2                                      | 0                      |
| 2012 | 14 300               | 479                    | 14 043                  | 29.3                                      | 0                      |
| 2013 | 14 242               | 468                    | 13 550                  | 29.0                                      | 0                      |
| 2014 | 14 218               | 3 506                  | 9 771                   | 2.8                                       | 0                      |
| 2015 | 14 425               | 3 357                  | 9 442                   | 2.8                                       | 0                      |
| 2016 | 14 561               | 3 504                  | 9 858                   | 2.8                                       | 0                      |
| 2017 | 14 463               | 3 447                  | 9 041                   | 2.6                                       | 0                      |
| 2018 | 14 337               | 3 282                  | 8 685                   | 2.6                                       | 0                      |
| 2019 | 13 693               | 3 264                  | 8 993                   | 2.6                                       | 1                      |
| 2020 | 13 506               | 2 927                  | 8 701                   | 3.0                                       | 0                      |
| 2021 | 13 389               | 3 123                  | 9 089                   | 2.9                                       | 0                      |
| 2022 | 13 182               | 3 129                  | 8 910                   | 2.8                                       | 0                      |
| 2023 | 13 048               | 3 258                  | 9 416                   | 2.9                                       | 0                      |

\* Based on data from the register of production subsidies as of 31<sup>st</sup> of July the respective year until 2017. Thereafter, data from 1<sup>st</sup> of March was used.

\*\* Sampling period: 20<sup>th</sup> of November to 31<sup>st</sup> of December.

## Goats

A total of 1,674 samples from 57 goat herds were received. The NFSA made a decision not to test 865 samples received after 31<sup>st</sup> of October. Thus, 809 samples from 27 goat herds were tested for antibodies against SRLV (Table 2). This was approximately 1.8% of Norwegian goat herds.

Of the samples, 806 samples tested negative and three individuals tested positive for SRLV (0.4%) with the IDvet ELISA. The three positive samples in the IDvet ELISA gave negative results with the Hyphen ELISA. No goat herd was concluded to be positive for CAE in the surveillance programme.

**Table 2: The results and total number of goat herds within the frame of the Norwegian surveillance programme for small ruminant lentivirus 2018-2023.**

| Year | Total no. of herds* | No. of herds analysed | No. of animals analysed | Average no. of animals analysed per herd | No. of positive herds |
|------|---------------------|-----------------------|-------------------------|--|-----------------------|
| 2018 | 1 246               | 61                    | 1 663                   | 27.2                                     | 1                     |
| 2019 | 1 209               | 58                    | 1 751                   | 30.2                                     | 1                     |
| 2020 | 1 270               | 50                    | 1 443                   | 28.9                                     | 0                     |
| 2021 | 1 359               | 52                    | 1 540                   | 29.6                                     | 2                     |
| 2022 | 1 412               | 59                    | 1 798                   | 30.5                                     | 2**                   |
| 2023 | 1 529               | 27                    | 809                     | 30.0                                     | 0                     |

\* Based on data from the register of production subsidies as of 1<sup>st</sup> of March the respective year.

\*\* Two herds with continuous restrictions from 2012 and 2013, respectively.

## Discussion

During the years 2003-2008, ram circles and their flocks registered as members of The Norwegian Association of Sheep and Goat Farmers constituted the target population for the programme. Approximately 90% of the Norwegian sheep flocks participating in ram circles were screened for antibodies against SRLV during 2003 to 2005. These herds were retested during 2006 to 2008. In 2009, breeding flocks of other sheep breeds than those represented by The Norwegian Sheep and Goat Breeders Association were selected for sampling. During 2010-2013, randomly selected sheep flocks were sampled. During this period (2003-2013), all samples were collected from live animals at the farms.

From 2014, sheep have been sampled at slaughterhouses, giving a better surveillance of the total population with the use of less resources than needed when sampling on farms (7). However, less animals were tested per herd, giving less accurate results on the herd level.

In goats, the surveillance is still based on sampling live animals in the herds.

Results from the surveillance programme for maedi from November 2003 through 2006, showed a prevalence of less than 0.2% positive flocks. The distribution of the disease indicated that it was regionally clustered. A more extensive spread of MVV virus from the outbreak in 2003 was probably prevented by the restrictions on transfer of sheep across county borders. Maedi was not detected in the surveillance programme in the years 2005 to 2018. Even if maedi was detected in nine flocks in total during 2019 and 2020, the prevalence of infected flocks remains very low (less than 0.07%).

In 2023, the confirmatory test was changed from the IDEXX MVV/CAEV p28 Ab Verification Test to Hyphen ELISA because IDEXX discontinued production of the test. The change of testing regime was supported by the findings of Jerre *et al.* (9), where serial testing with IDvet and Hyphen ELISA gave the highest sensitivity and specificity among the tests evaluated. The study also found that the specificity of the Hyphen ELISA was lower than that of the IDEXX ELISA, which is reflected in an increased number of samples and herds that required follow-up testing.

In addition to testing samples from the surveillance programme, sheep and goat herds are tested in relation with animal trade. During the autumn of 2023, three and five animals from two sheep flocks, respectively, tested positive in both IDvet ELISA and Hyphen ELISA. The results remained after retesting in duplicates. These flocks were subject to restrictions due to suspicion of maedi. After several rounds of resampling and retesting, all but one animal in each flock turned out negative, and the restrictions were lifted in both flocks. The remaining positive or doubtful animals were slaughtered, and the flocks were not diagnosed with maedi.

One goat herd in which several animals were positive for antibodies against SRLV was detected in October 2023 based on samples taken in relation with livestock trade, and the herd was diagnosed with CAE.

All dairy goat herds in Norway and many meat and fibre goat herds were part of the eradication programme Healthier goats which was active during 2001 to 2014. This has resulted in improved goat health and welfare in the Norwegian goat industry (6, 8). The finding of CAE in the years 2019 to 2021 in several hobby and meat goat herds, as well as in dairy goat herds where CAE previously had been eradicated, shows that control and continued surveillance is needed in all types of goat herds.

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