

# The surveillance programme for specific viral infections in swine herds in Norway 2018



**Veterinærinstituttet**  
Norwegian Veterinary Institute



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## Summary

The surveillance programme for specific viral infections in swine herds in 2018 continued to show Norway to be free from Aujeszky's disease, transmissible gastroenteritis, porcine epidemic diarrhoea virus and porcine respiratory and reproductive syndrome.

Norway recorded its first outbreak of influenza A (H1N1) pdm09 virus (H1N1pdm) in 2009, after which a stable herd prevalence indicated endemicity in the following years. For the first time since 2010, the national herd prevalence in 2018 fell below 40% at 25% (95% CI 22-30% or 138/ 534 herds) although the region of Rogaland and Agder with the highest number and density of pig herds, continued to have the highest herd prevalence at 50% (95% CI 41-58%). Except for H1N1pdm, Norwegian swine population was tested negative against other strains of influenza A virus that are endemic in most pig producing countries.

During August 2018, antibodies against porcine respiratory corona virus (PRCV) were detected in seven swine herds in the county of Rogaland through the surveillance programme. An outbreak investigation was initiated, demonstrating antibodies against PRCV in 40 out of 59 (68%) tested contact herds. Combined herd prevalence for PRCV in these two counties was 47% (95% CI 35-60% or 31/65) herds. During 2018, only two herds outside the counties of Rogaland and Agder tested positive for antibodies against PRCV. The first of these herds received pigs from Rogaland and the second received pigs from the first herd.

## Introduction

The Norwegian Food Safety Authority (NFSA) is responsible for implementing the surveillance programme for specific viral infections in swine. The national surveillance programme for specific viral infections in swine was launched in 1994 to document the status of Aujeszky's disease (AD), transmissible gastroenteritis (TGE), and porcine respiratory corona virus (PRCV) in the Norwegian swine population. Porcine respiratory and reproductive syndrome (PRRS) and swine influenza (SI) were added to the programme in 1995 and 1997, respectively. From 1997 to 1999, and again from 2015, porcine epidemic diarrhoea (PED) was also included in the programme. The Norwegian Veterinary Institute is responsible for sampling plans, laboratory investigations and reporting components of the programme.

The EFTA Surveillance Authority (ESA) has recognized Norway's disease-free status for AD since July 1 1994, and has laid down additional measures for the trade of pigs and pork to protect Norway's disease free status for AD. The additional measures are described in ESA Decision No 160/10/COL.

## Aims

The aims of the serological surveillance programme are to ascertain the continued absence of the specific infectious viral diseases and to contribute to the maintenance of this favourable situation. The programme also monitors the status of H1N1pdm, and from 2018 also PRCV, in the Norwegian swine population.

## Materials and methods

### Herds and sampling

Eighty-three out of 88 nucleus and multiplying herds as well as the central-units of all 12 sow pools were included in the programme. Blood samples (target sample size of 10 pigs) from adult swine in each herd were collected, usually at the farms, but occasionally also at the abattoirs. In addition, a selection of the remaining Norwegian swine herds was included in the programme. At the 12 largest abattoirs where more than 97% of the pig slaughter takes place, blood samples proportional to the number of sows and boars per herd were collected. The samples were randomly collected from different herds and the sampling periods were evenly distributed throughout the year. Furthermore, at the six largest abattoirs, blood samples (targeted sample size 10 pigs) were collected from 45 randomly selected large fattening herds.

The detection of antibodies against PRCV in August 2018 prompted a recommendation to monitor any potential further dissemination outside the counties of Rogaland and Vest-Agder. A strengthened surveillance in nucleus and multiplier pig herds was conducted, including sampling of these herd categories outside Rogaland and Vest-Agder after September 1<sup>st</sup> 2018, irrespective of whether or not they had been sampled earlier in 2018.

### Laboratory analyses

All serological analyses were performed at the Norwegian Veterinary Institute in Oslo. Positive or inconclusive results in the surveillance programme were retested in duplicate with the same test method. Samples were concluded as negative if the retest gave a negative result. If the result of the retest was positive or inconclusive, a specified confirmatory test was performed. In cases of positive or inconclusive test results for confirmatory tests (except for H1N1pdm virus which is enzootic in Norway), at least 20 new pigs were resampled from the herd in question. If clinical signs of disease were absent in the herd, and all resampled animals were negative for antibodies against the pathogen in question, a single positive or inconclusive sample in the surveillance programme was considered false positive.

#### *Aujeszky's disease/pseudorabies virus (ADV/PRV)*

All serum samples were tested for antibodies against ADV using a commercial blocking ELISA from Svanova (SVANOVIR® PRV gB-Ab). The test detects antibodies against glycoprotein B (previously glycoprotein II) found on the surface of the virus.

#### *Transmissible gastroenteritis virus (TGEV) and porcine respiratory coronavirus (PRCV)*

A commercial blocking ELISA from Svanova (SVANOVIR® TGEV/PRCV-Ab) was used to detect antibodies against TGEV/PRCV. The ELISA test enables discrimination between antibodies to TGEV and PRCV in serum samples. Since antibodies against PRCV were not detected in Norway until 2018, a selection of the positive samples analysed in September 2018 were sent to the National Veterinary Institute (DTU Vet) in Denmark for confirmatory testing. All the samples were confirmed positive for antibodies against PRCV by virus neutralization test and ELISA

#### *Porcine reproductive and respiratory syndrome virus (PRRSV)*

All serum samples were tested for antibodies against PRRSV using a commercial indirect ELISA from IDEXX (IDEXX PRRS X3), which detects the most (pre)dominant European and American strains of PRRSV. In cases of positive or inconclusive results, the samples were sent to the National Veterinary Institute (DTU-Vet) in Denmark for confirmatory testing using ELISA and immunoperoxidase tests for detection of antibodies against EU- and US-strains of the PRRSV and real-time PCR for PRRSV.

#### *Swine influenza virus (SIV)*

A commercial competitive ELISA from IDvet (ID Screen® Influenza A Antibody Competition, Multi-species) was used to screen serum samples from swine for antibodies against influenza A virus. In cases of positive or inconclusive results, the serum samples were retested using the haemagglutination inhibition (HI) test, for the detection of antibodies against the A/Swine/California/07/09 (A/H1N1/pdm09), A/Swine/Belgium/1/98 (H1N1), A/Swine/Gent/7623/99 (H1N2) and A/Swine/Flanders/1/98 (H3N2) subtypes as described in the OIE Manual of Diagnostic Tests and Vaccines for Terrestrial Animals (1). The antigens for the tests were produced at the Norwegian Veterinary Institute.

#### *Porcine epidemic diarrhoea virus (PEDV)*

All serum samples were tested for antibodies against PEDV using a commercial indirect ELISA from IDvet (ID Screen® PEDV Indirect). In cases of positive or inconclusive results, the samples were sent to the National Veterinary Institute (DTU-Vet) in Denmark for confirmatory testing using an in-house ELISA.

## Results and Discussion

The distribution of sampled herds in relation to production type is given in Table 1. The mean number of animals tested per farm aggregated for the year was 7 (range 1 - 40). Only a few of the collected samples were rejected, resulting in 3,598 individual pig samples representing 533 herds being analysed (Table 2). Of the 533 tested herds, 134 (25%) were seropositive for H1N1pdm. The proportion of herds tested positive by region varied from 10% in the aggregated counties of Finnmark/Troms/Nordland to 49% in the counties of Rogaland and Agder (Table 3, Figure 1).

**Table 1.** Distribution of swine herds in the surveillance programme 2018 according to type of production and the results for antibodies to H1N1pdm.

Category	No. of herds sampled	No. (%) of positive herds H1N1pdm
Nucleus herds and multiplying herds	83	16 (19)
Sow pools	12	7 (58)
Integrated and piglet-producing herds	393	109 (28)
Fattening herds	45	4 (9)
Total herds (pigs)	533	134 (25)

**Table 2.** Results from the surveillance for Aujeszky's disease (AD), transmissible gastroenteritis (TGE), porcine respiratory corona virus (PRCV), porcine epidemic diarrhoea (PED), porcine respiratory and reproductive syndrome (PRRS) and swine influenza (SI) from 1994 to 2018.

Year	Total no. of herds	Herds tested	Animals tested	H1N1pdm		PRCV		Other viruses		Diseases included
				Animals positive <sup>3</sup>	Herds positive	Animals positive	Herds positive	Animals positive	Herds positive	
1994	7 799	1 112	12 010	-	-	0	0	0	0	AD, TGE/PRCV
1995	7 471	956	11 197	-	-	0	0	0	0	AD, TGE/PRCV, PRRS
1996	7 045	468	4 968	-	-	0	0	0	0	AD, TGE/PRCV, PRRS
1997	6 661	512	4 925	-	-	0	0	0	0	AD, TGE/PRCV, PRRS, SI, PED
1998	6 275	491	4 695	-	-	0	0	2 <sup>1</sup>	1 <sup>1</sup>	AD, TGE/PRCV, PRRS, SI, PED
1999	5 761	470	4 705	-	-	0	0	0	0	AD, TGE/PRCV, PRRS, SI, PED
2000	4 827	458	4 600	-	-	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2001	4 554	472	4 972	-	-	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2002	4 150	492	4 899	-	-	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2003	4 005	483	4 783	-	-	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2004	4 006	492	4 935	-	-	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2005	3 762	468	4 644	-	-	1 <sup>2</sup>	1 <sup>2</sup>	0	0	AD, TGE/PRCV, PRRS, SI
2006	3 339	457	4 569	-	-	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2007	3 010	456	4 641	-	-	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2008	2 682	487	4 845	-	-	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2009	2 546	452	4 724	131	20	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2010	2 441	459	4 250	940	189	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2011	2 346	730	4 713	2 216	353	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2012	2 213	764	4 961	2 412	378	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2013	2 178	737	5 038	1 417	338	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2014	2 117	622	4 083	1 138	296	0	0	0	0	AD, TGE/PRCV, PRRS, SI
2015	2 141	568	3 764	993	280	0	0	0	0	AD, TGE/PRCV, PRRS, SI, PED
2016	2 180	564	3 824	952	271	0	0	0	0	AD, TGE/PRCV, PRRS, SI, PED
2017	1 955	548	3 804	695	225	0	0	0	0	AD, TGE/PRCV, PRRS, SI, PED
2018	2 038	533	3 598 <sup>3</sup>	473	134	126 <sup>4</sup>	30 <sup>4</sup>	0	0	AD, TGE/PRCV, PRRS, SI, PED
Total			128 147							

1 Two samples from one herd were seropositive for SI H3N2 in 1998 (probably infection from humans)

2 One sero-positive sample for PRCV in 2005 (probably unspecific reaction).

3 Maximum 5 influenza A positive samples per submission were followed up with a HI-test to identify the influenza strain.

4 In addition to routine surveillance for PRCV, NVI also detected 238 positive pigs in 30 positive herds (27 in Rogaland, 1 in Vest-Agder and 2 in Hedmark)

Table 3. Number of herds tested and percentage of herds positive for H1N1pdm by county in 2018.

Region	Total herds	No. of herds tested	No. of herds tested positive	Percentage of herds tested positive (95% CI)
Finnmark/Troms/Nordland	119	31	3	10 (3-27)
Trøndelag/Møre and Romsdal	384	120	24	20 (13-28)
Hordaland/Sogn and Fjordane	148	26	4	15 (5-36)
Rogaland/Agder	615	132	65	49 (40-58)
Buskerud/Vestfold/Telemark	187	63	6	10 (4-20)
Oslo/Akershus/Østfold	201	62	9	15 (7-26)
Hedmark/Oppland	384	94	23	24 (16-35)
Total	2 038	528	134	25 (22-29)

Table 4. Number of herds tested and percentage of herds positive for PRCV from August to December 2018.

Region	Total herds	No. of herds tested (Aug-Dec)	No. of herds tested positive	Percentage of herds tested positive (95% CI)
Finnmark/Troms/Nordland	119	21	0	0
Trøndelag/Møre and Romsdal	384	41	0	0
Hordaland/Sogn and Fjordane	148	8	0	0
Rogaland/Agder	615	64	30	47 (34-60)
Buskerud/Vestfold/Telemark	187	19	0	0
Oslo/Akershus/Østfold	201	28	0	0
Hedmark/Oppland	384	61	0	0
Total	2 038	242	30	12 (9-17)

The results from the surveillance programme in 2018 showed that Norway has maintained its freedom of disease status for AD, TGE and PRRS virus infections in the national swine population since the surveillance started in 1994.

Porcine respiratory coronavirus is a variant of transmissible gastroenteritis virus (TGEV). PRCV likely emerged naturally and subsequently spread rapidly in the European swine populations during the early 1980's, causing mostly unapparent infections and ameliorating TGE through immunological cross-protection (2). Based on surveillance data from this and previous years, it is likely that the introduction of PRCV to the Norwegian pig population occurred during 2018. The outbreak investigation conducted by the NFSA further showed that the virus spread rapidly to a high proportion of herds connected by trade of live pigs, but also herds located <3km from PRCV antibody positive herds (Figure 2). The route of introduction was not identified, but further virological investigations and continued serological surveillance are ongoing. Based on the epidemiological features of PRCV and data from other countries, it appears likely that PRCV will become endemic in the Norwegian pig population.

With regards to influenza A, studies have shown that the H1N1pdm virus was most likely introduced to pigs by humans infected with the same virus (3, 4). The herd seroprevalence for H1N1pdm fell by 16 percentage points, from 41% in 2017 to 25% in 2018. The decline from 2017 in herd prevalence was across all four production types and across all counties (Tables 1 and 3). The decline of seropositive herds may be correlated to the relatively low A H1N1pdm incidence in the human population during 2017(5). This suggests that antroponotic transmission may have contributed to a proportion of new infections in pig herds during previous years when H1N1pdm was the dominant human influenza strain in Norway. The herd prevalence in Rogaland/Agder region, the densest pig farming area in Norway, also declined by 16 percentage point. However, it remained the highest at 49% indicating a continued endemic situation.

## Influenza A (H1N1)pdm09 serosurveillance in Norwegian swine herds 2018

- Positive H1N1pdm
- Negative herds
- Other swine herds

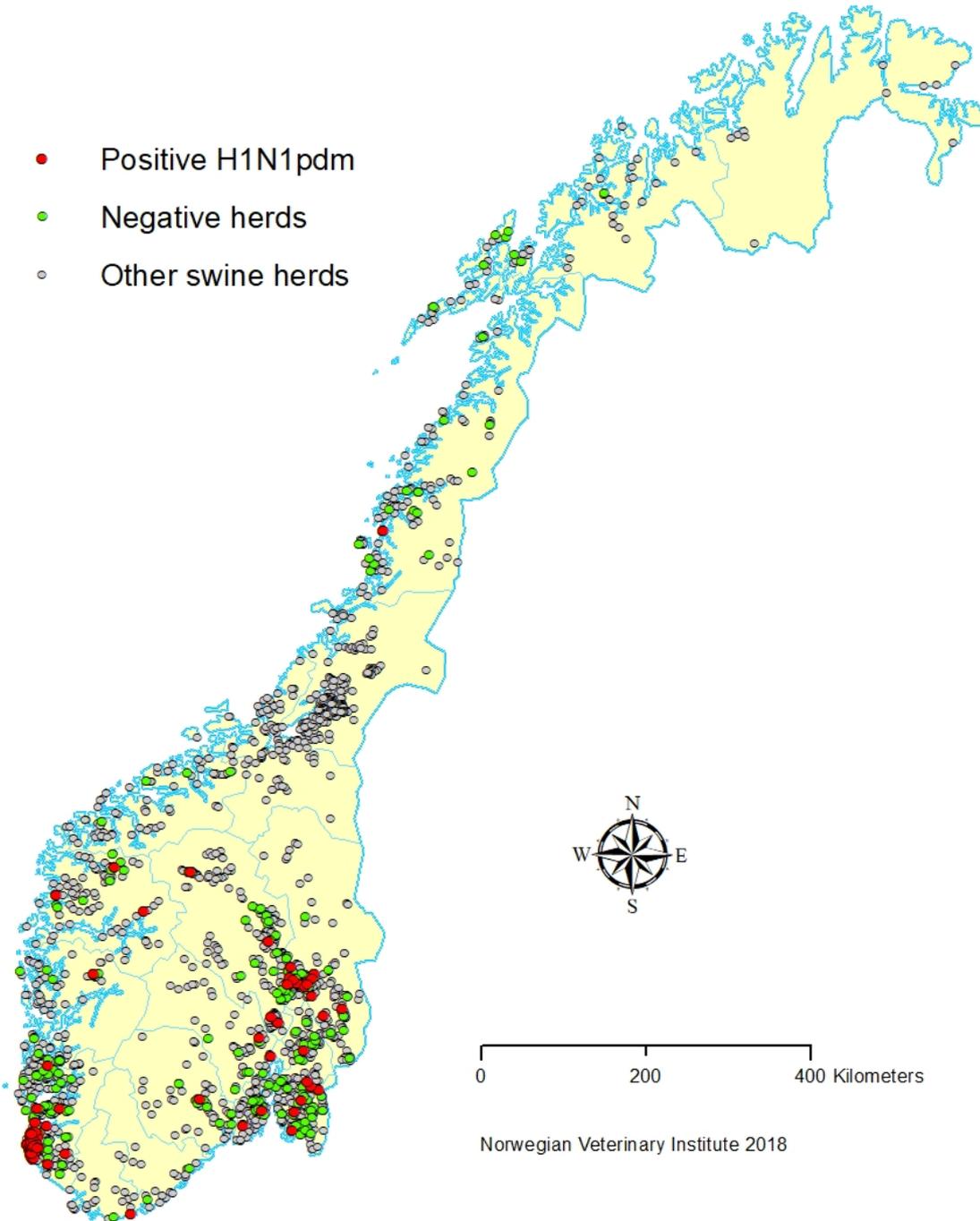
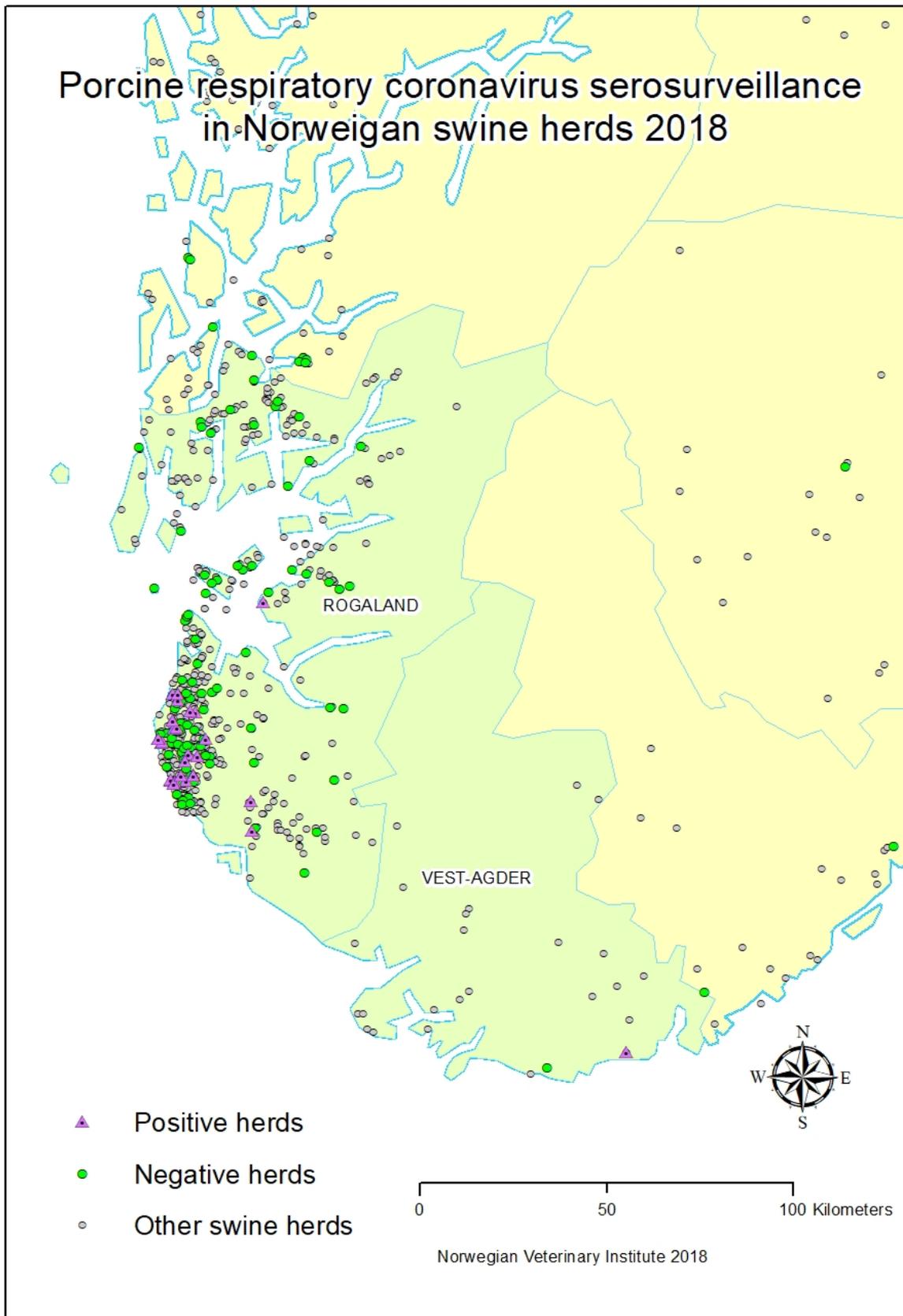


Figure 1. Serological results and geographical distribution of swine herds tested for antibodies against influenza A virus in the surveillance programme for specific viral infections in 2018.



**Figure 2.** Serological results and geographical distribution of swine herds tested for antibodies against porcine respiratory coronavirus surveillance in Norwegian swine herds in the surveillance programme for specific viral infections in 2018. Positive herds were discovered only in two counties through routine surveillance, Rogaland (n=30) and Vest-Agder (n=1). The map shows the south-western part of Norway.

The surveillance in 2018 showed that Norway continued to be free from other influenza A subtypes that are endemic in most pig producing countries.

Swine influenza A H1N1pdm infection in Norwegian pig herds have mainly been subclinical or with mild clinical signs in a small proportion of the herds (3, 6, 7). A longitudinal study from a Norwegian boar testing station published in 2014 showed that infected growing pigs had reduced feed efficiency due to poorer feed conversion ratio and as such increase the time to market (8).

The Norwegian swine production has recent years had stabilization in the number of herds, while the average herd size is increasing. The pork production by tonnage has remained relatively stable. Due to changes in the sampling procedure for conventional herds with sows in 2011, the fraction of the total pig herd population sampled increased from 19 % in 2010 to 31 % in 2011. Since 2014, this proportion has been between 29% and 26%, while the mean number of samples per herd decreased.

Farmed wild boars and pigs kept as pets were not included in the programme, however these populations are very small and with little to no contact with the commercial pig population. There is a small, but increasing wild boar population in a local area along the Swedish border in the South-East of Norway.

Apart from AD, the EU has not approved additional guarantees (safeguards) against other swine viral infections when importing pigs into Norway. To protect the swine population against disease-related risks, Norway has its own national guidelines for the trade of live swine and pork products.

In conclusion, the surveillance programme for specific viral infections in 2017 demonstrates that Norwegian pig herds remained free from several serious infectious diseases, hence documenting Norwegian pig herd's favourable health status.

## References

1. Office International des Epizooties. Manual of diagnostic tests and vaccines for terrestrial animals 2011. Web version (<http://www.oie.int/international-standard-setting/terrestrial-manual/access-online/>).
2. Laude H, Van Reeth K, Pensaert M. Porcine respiratory coronavirus: molecular features and virus-host interactions. *Vet Res.* 1993, 24 (2): 125-50
3. Hofshagen M, Gjerset B, Er C, Tarpai A, Brun E, Dannevig B, Bruheim B, Fostad IG, Iversen B, Hungnes O, Lium B. Pandemic influenza A(H1N1)v: Human to pig transmission in Norway? *Euro Surveill.* 2009;14(45):pii=19406. (<http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=19406>)
4. Grøntvedt CA, Er C, Gjerset B, Hauge AG, Brun E, Jørgensen A, Lium B, Framstad T. influenza A(H1N1)pdm09 virus infection in Norwegian swine herds 2009/10: The risk of human to swine transmission. *Prev Vet Med* 2013; 110: 429-34
5. Norwegian Institute of Public Health. Influenza surveillance week 22. 2017 report (Norwegian). Web link: <https://www.fhi.no/contentassets/09fa02b8ebd94549b40d146eee49caea/vedlegg/2017-22-influensaovervaking-2016-2017-uke-22.pdf>
6. Gjerset B, Er C, Løtvedt S, Jørgensen A, Hungnes O, Lium B, Germundsson A. Experiences after twenty months with pandemic influenza A (H1N1) 2009 infection in the naïve Norwegian pig population. *Influenza Research and Treatment* Vol 2011, Article ID 206975, 7 pages. Doi:10.1155/2011/206975
7. Grøntvedt CA, Er C, Gjerset B, Germundsson B, Framstad F, Brun E, Jørgensen A, Lium B. Clinical impact of infection with pandemic influenza (H1N1) 2009 virus in naïve nucleus and multiplier pig herds in Norway. *Influenza Research and Treatment* Vol 2011, Article ID 163745, 6 pages doi:10.1155/2011/163745
8. Er, C., B. Lium, S. Tavorpanich, P. Hofmo, H. Forberg, A. Hauge, CA. Grøntvedt, T. Framstad, and E. Brun. 2014. Adverse effects of Influenza A(H1N1)pdm09 virus infection on growth performance of Norwegian pigs - a longitudinal study at a boar testing station. *BMC Vet Res* no. 10 (1):284. doi: 10.1186/s12917-014-0284-6.

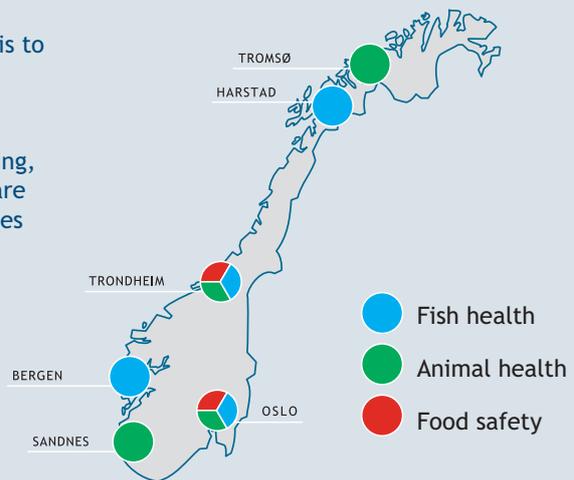
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