



The surveillance programme for specific viral infections in swine herds in Norway 2021



REPORT 52/2022

The surveillance programme for specific viral infections in swine herds in Norway 2021

Authors

Carl Andreas Grøntvedt, Anne Bang Nordstoga, Petter Hopp

Suggested citation

Grøntvedt, Carl Andreas, Nordstoga, Anne Bang, Hopp, Petter. The surveillance programme for specific viral infections in swine herds in Norway 2021. Surveillance program report. Veterinærinstituttet 2022. © Norwegian Veterinary Institute, copy permitted with citation

Quality controlled by

Merete Hofshagen, Director of Animal Health, Animal Welfare and Food Safety, Norwegian Veterinary Institute

Published

2022 on www.vetinst.no

ISSN 1890-3290 (electronic edition)

© Norwegian Veterinary Institute 2022

Commissioned by / In collaboration with

Norwegian Food Safety Authority



Colophon

Cover design: Reine Linjer

Cover photo: Colourbox

www.vetinst.no

Content

Summary	3
Introduction	3
Aims	4
Materials and methods	4
Herds and sampling.....	4
Laboratory analyses	4
Results and Discussion	5
Acknowledgement	11
References	11

Summary

The surveillance programme for specific viral infections in swine herds in 2021 continued to show Norway to be free from Aujeszky's disease, transmissible gastroenteritis, porcine epidemic diarrhoea and porcine respiratory and reproductive syndrome.

Since 2009, influenza A (H1N1) pdm09 virus (H1N1pdm) has been endemic in the Norwegian swine population, showing a decline in seroprevalence to approx. 20% of herds testing positive during the last year. Other swine-associated influenza strains have never been diagnosed in Norway.

In 2018, porcine respiratory corona virus (PRCV) was detected for the first time in Norway, and the seroprevalence in the southwestern part of the country has since been high and also increasing in other parts of Norway.

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 (NVI) 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 1st July 1994. Additional measures for the trade of pigs have been laid down to protect Norway's disease free status for AD. The additional measures are described in ESA Decision No 032/21/COL.

PRRS, TGE and PED have never been detected in Norway.

Norway recorded its first outbreak of influenza A (H1N1) pdm09 virus (H1N1pdm) in the swine population in 2009, and in the following years, a stable herd prevalence of between 40 and 50% indicated endemicity. In 2018, the national herd prevalence was reduced to 25%, and has remained at this level or lower during the last four years. The region of Rogaland and Agder, with the highest number and density of pig herds, has continued to have the highest herd prevalence at 46% (95% CI 38-54%).

In August 2018, antibodies against porcine respiratory corona virus (PRCV) were detected in seven swine herds in the county of Rogaland through the surveillance programme, and an outbreak investigation revealed PRCV specific antibodies in a high proportion (68%) of contact herds sampled.

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

All 78 nucleus and multiplying herds as well as the central-units of all 11 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 abattoirs, but occasionally also at the farms. In addition, a selection of the remaining Norwegian swine herds was included in the programme. At the 14 abattoirs where more than 99% of the pig slaughter takes place, blood samples proportional to the number of sows and boars slaughtered were collected. The samples were randomly collected from different herds and the sampling periods were evenly distributed throughout the year. Furthermore, at the seven largest abattoirs, blood samples (targeted sample size 10 pigs) should be collected from 7 randomly selected large fattening herds at each abattoir, in total 49 herds.

Laboratory analyses

All serological analyses were performed at NVI. 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 and PRCV), at least 10 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. Positive or inconclusive samples were further analysed with ID Screen Aujeszky gE Competition ELISA at the NVI.

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. TGEV positive or inconclusive samples were tested with a confirmatory test at the NVI (Swinecheck®TGEV/PRCV, Biovet), or at Statens Serum Institut (SSI) in Denmark.

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 type-1 and type-2 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 multiplex serology and immunoperoxidase tests for detection of antibodies against EU- and US-strains of the PRRSV and real-time PCR for PRRSV.

Swine influenza virus

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 NVI.

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 SSI in Denmark for confirmatory testing.

Results and Discussion

The mean number of animals tested per farm aggregated for the year was seven (range 1 - 43). Less than 1% of the collected samples were rejected, resulting in 4,012 individual pig samples representing 521 herds being analysed (Table 1). Distribution of sampled herds in relation to production type is given in Table 2. The proportion of herds tested positive by region are presented in Table 3. Of the 521 tested herds, 102 (19.6%) were seropositive for H1N1pdm (Table 2, Figure 2) and 201 (38.6%) were positive for PRCV (Table 2, Figure 1).

Table 1: 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 2021.

Year	Total no. of herds	Herds tested	Animals tested	H1N1pdm		PRCV		Other viruses		Diseases included in other viruses
				Animals positive ³	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 ¹	1 ¹	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 ²	1 ²	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 ³	473	134	126 ⁴	30 ⁴	0	0	AD, TGE/PRCV, PRRS, SI, PED
2019	1 853	545	3 838 ³	526	153	532	118	0	0	AD, TGE/PRCV, PRRS, SI, PED
2020	1 724	527	3 851 ³	534	125	753	182	0	0	AD, TGE/PRCV, PRRS, SI, PED
2021	1 693	521	4 012 ³	394	102	904	201 ⁵	0	0	AD, TGE/PRCV, PRRS, SI, PED
Total			139 848							

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 and not included in this table, NVI also detected 238 positive pigs in 30 positive herds (27 in Rogaland, 1 in Vest-Agder and 2 in Hedmark).

⁵ In three herds, serological analysis were inconclusive for antibodies against TGEV while antibodies against PRCV were detected. We consider it likely that this is due to serological cross-reactions between PRCV and TGEV. See discussion for details.

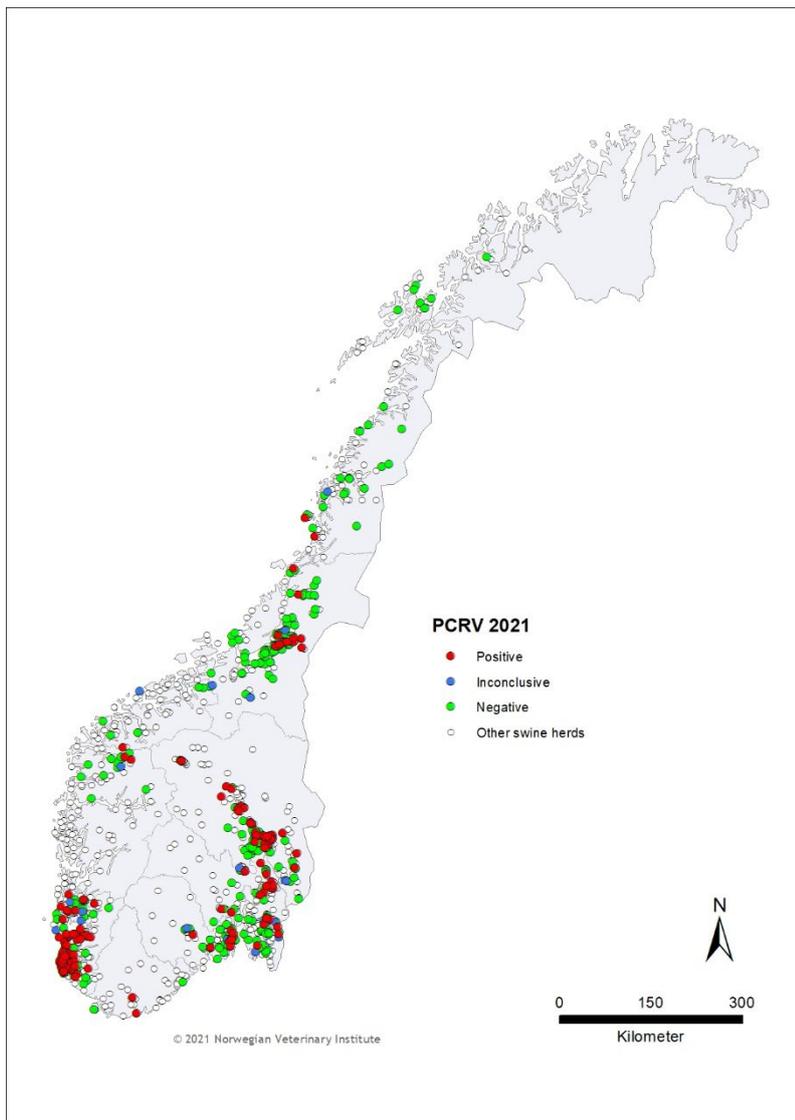


Figure 1: Serological results and geographical distribution of swine herds tested for antibodies against porcine respiratory coronavirus in the surveillance programme for specific viral infections in 2021.

Table 2: Distribution of swine herds in the surveillance programme 2021 according to type of production and the results for antibodies to H1N1pdm and PRCV.

Category	No. of herds sampled	No. (%) of positive herds H1N1pdm	No. (%) of positive herds PRCV
Nucleus herds and multiplying herds	76	13 (17.1)	28 (36.8)
Sow pools	11	4 (36.4)	10 (90.9)
Integrated and piglet-producing herds	377	82 (21.8)	144 (38.2)
Fattening herds	57	3 (5.3)	19 (33.3)
Total herds (pigs)	521	102 (19.6)	201 (38.6)

Table 3: Number of herds tested and percentage of herds positive for PRCV per region in 2021. The total number of herds is based on Register of Production Subsidies as of 1st March 2021.

Region	Total no. of herds	No. of herds tested	No. of herds tested positive	No. of herds tested inconclusive	Percentage of herds tested positive (95% CI)
Troms og Finnmark, Nordland	96	29	2	1	6.9 (0.8 - 22.8)
Trøndelag, Møre og Romsdal	332	117	14	6	12.0 (6.7 - 19.3)
Vestland	118	22	5	1	22.7 (7.8 - 45.4)
Rogaland, Agder	516	160	116	6	72.5 (64.9 - 79.3)
Vestfold og Telemark	126	37	10	3	27.0 (13.8 - 44.1)
Oslo, Viken	196	60	17	5	28.3 (17.5 - 41.4)
Innlandet	309	96	37	5	38.5 (28.8 - 49.0)
Total	1 693	521	201	27	38.6 (34.4 - 42.9)

The results from the surveillance programme in 2021 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 (PRCV) is a variant of transmissible gastroenteritis virus (TGEV). PRCV likely emerged naturally and subsequently spread rapidly in the European swine populations during the early 1980s, 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 to herds located less than 3 km from PRCV antibody positive herds. The route of introduction to Norway was not identified. 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. In 2021, the national herd seroprevalence for PRCV was estimated to 38.6%. In the counties of Rogaland and Agder the PRCV herd seroprevalence was 72.5%, while the corresponding herd seroprevalence was 23.5% outside Rogaland and Agder.

In three herds, serology for TGEV was inconclusive while antibodies against PRCV were detected. There were no reports of clinical suspicion of respiratory or enteric disease in the three herds. Unfortunately, two of the herds did not have pigs at the time of follow-up and were as such unavailable. Follow-up samples from the third herd showed 8 out of 10 samples being negative and 2 inconclusive with regards to antibodies against TGEV. We consider it likely that the inconclusive results for antibodies against TGEV was due to serological cross-reactions to PRCV, as this has also been reported from other populations (3).

Table 4: Number of herds tested and percentage of herds positive for H1N1pdm per region in 2021. The total number of herds is based on Register of Production Subsidies as of 1st March 2021.

Region	Total herds	No. of herds tested	No. of herds tested positive	Percentage of herds tested positive (95% CI)
Troms og Finnmark, Nordland	96	29	0	0 (0 - 11.9)
Trøndelag, Møre og Romsdal	332	117	8	6.8 (3.0 - 13.0)
Vestland	118	22	1	4.5 (0.1 - 22.8)
Rogaland, Agder	516	160	74	46.2 (38.3 - 54.3)
Vestfold og Telemark	126	37	2	5.4 (0.7 - 18.2)
Oslo, Viken	196	60	9	15.0 (7.1 - 26.6)
Innlandet	309	96	8	8.3 (3.7 - 15.8)
Total	1 693	521	102	19.6 (16.3 - 23.2)

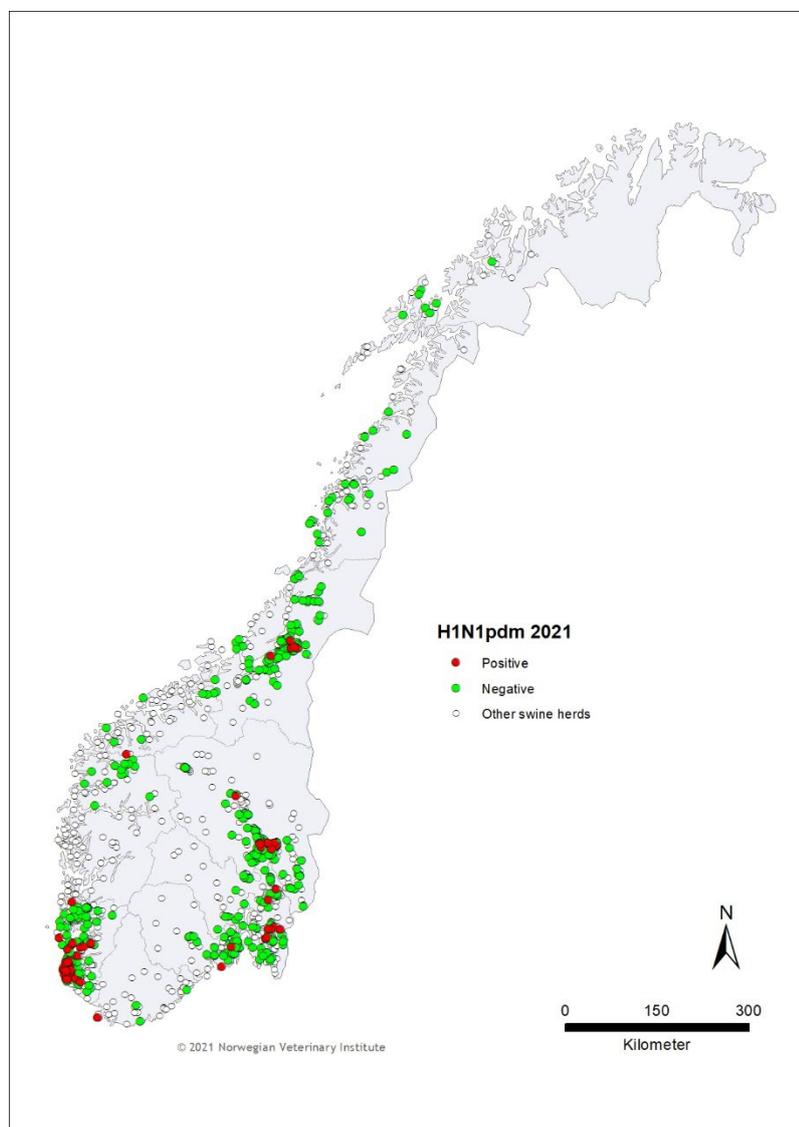


Figure 2: Serological results and geographical distribution of swine herds tested for antibodies against influenza A virus in the surveillance programme for specific viral infections in 2021.

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 (4, 5). The herd seroprevalence for H1N1pdm has decreased from 41% in 2017 to less than 20% in 2021, however the reasons for this decline are not known. The decline from 2017 in herd prevalence was across all four production types and across all counties (Tables 2 and 4). The herd prevalence in Rogaland/Agder region, the densest pig farming area in Norway, remains the highest at 46.2% indicating a continued endemic situation. Except for H1N1pdm, the Norwegian swine population tested negative against other strains of influenza A virus 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 (4, 7, 8). 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 increased the time before being sent to slaughter (9).

In the recent years, the number of herds in the Norwegian swine production has stabilized while the average herd size has increased. The pork production by tonnage has remained relatively stable. In 2011, the sampling procedure for conventional herds with sows, changed from 10 samples collected in randomly selected herds to individual animals being collected at the abattoir. Therefore, the mean number of samples per herd decreased, while 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 26% and 31%, while the mean number of samples per herd has further decreased.

Farmed wild boars and pigs kept as pets were not included in the programme. These populations are small and have little to no contact with the commercial pig population. There is a small, but increasing wild boar population mainly in an area along the Swedish border in the southeast of Norway. A [wild boar health surveillance](#) was conducted during 2021 and is reported separately.

Apart from AD, the EU has not approved additional guarantees against other porcine viral infections for trading pigs into Norway. To protect the swine population against disease-related risks, Norway has its own national guidelines for the trade of live pigs.

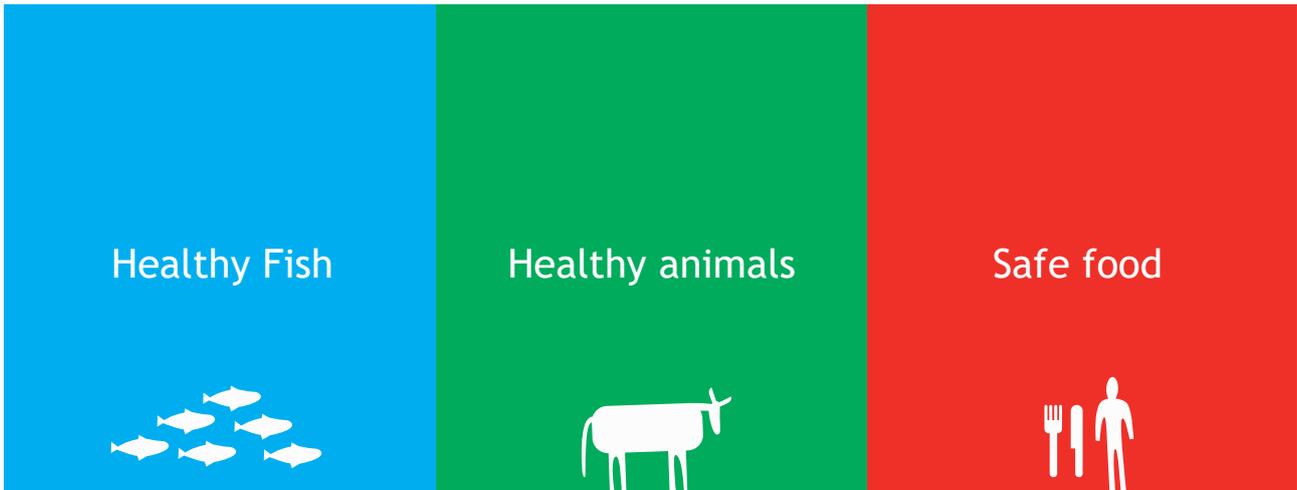
In conclusion, the surveillance programme for specific viral infections in 2021 documents Norwegian pig herd's favourable health status by demonstrating that Norwegian pig herds remained free from the serious infectious diseases: AD, TGE, PRRS and PED. It also documents that SI other than H1N1pdm were not detected in the pig population.

Acknowledgement

The authors would like to thank the technical staff for performing the analyses with excellence, in particular Irene Haugen, Elisabeth Dahl Nybø, Tatiana Peacey, Nelya Emzeeva, Kristin Udjus, Krister Lundgård and Julia Martina Mallo Bakken. The authors would also like to thank Attila Tarpai, Norwegian Veterinary Institute for his kind assistance with preparing the maps included in this report. Moreover, the authors would like to thank all personnel from the Norwegian Food Safety Authority for collection and submission of samples.

References

1. World Organization for Animal Health (Founded as Office International des Epizooties). Manual of diagnostic tests and vaccines for terrestrial animals 2018. Web version: (<https://www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-manual-online-access/>)
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. Magtoto R, Poonsuk K, Baum D, Zhang J, Chen, Q, Piñeyro P, Zimmerman J, Giménez-Lirola LG. Evaluation of the Serologic Cross-Reactivity between Transmissible Gastroenteritis Coronavirus and Porcine Respiratory Coronavirus Using Commercial Blocking Enzyme-Linked Immunosorbent Assay Kit. *mSphere* 4:e00017-19. <https://doi.org/10.1128/mSphere.00017-19>.
4. 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>)
5. 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
6. Kyriakis CS, Olsen C W, Carman S, Brown IH, Brookes SM, Doorselaere JV, Reeth K V. Serologic cross-reactivity with pandemic (H1N1) 2009 virus in pigs, Europe. *Emerg Infect Dis*, 2010. 16(1): p. 96-9.
7. 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
8. 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
9. Er, C., B. Lium, S. Tavornpanich, 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.



*Scientifically ambitious, forward-looking
and collaborative- for one health!*



Veterinærinstituttet
Norwegian Veterinary Institute

Ås

Trondheim

Sandnes

Bergen

Harstad

Tromsø

postmottak@vetinst.no
www.vetinst.no