Epidemiology of classical swine fever in Italy from 1970 to 1985

V. CAPORALE *, D. RUTILI **, D. NANNINI ***,
C. DI FRANCESCO *** and C. GHINATO ****

Summary: The epidemiology of classical swine fever (CSF) in Italy is analysed in order to evaluate the likelihood of success in control efforts. While the swine population is greatest in the north of the country, the disease has greater prevalence in the south, especially in Sardinia and Sicily. CSF is seasonal in Italy with peak incidence in the month of August and lesser peaks in February and April. Vaccination, however, is constant throughout the year and does not take into consideration the increase in susceptible populations during those months. CSF incidence is increasing in most EEC countries, which are the main source of Italy's swine and pork imports.

KEYWORDS: Disease control - Epidemiology - Italy - Swine diseases - Swine fever virus - Vaccination - Viral diseases.

INTRODUCTION

Since 1967, classical swine fever (CSF) prophylaxis in Italy has been based on both sanitary measures and annual compulsory vaccination of the swine population (1). Yearly outbreaks have decreased approximately twentyfold since the introduction of compulsory vaccination. The benefit/cost ratio of prophylaxis was calculated in 1979 to be 1.7 (Caporale, unpublished data).

Italy has had difficulties in the application of EEC Directive 80/1095, and the five-year eradication plan adopted in 1983 has been virtually abandoned at present.

It seems necessary, therefore, to analyse the epidemiology of CSF in Italy to assess the conditions necessary to make a national eradication plan feasible, in the light of the newest control and eradication methods (3).
MATERIALS AND METHODS

Sources of data

Data of swine populations are derived from the *Annuari Statistici della zootecnia pesca e caccia* published by the Istituto Centrale di Statistica (ISTAT, Rome).

Data on import-export of swine and swine products are derived from the bulletins of the Istituto per le Ricerche e le Informazioni di Mercato e la Valorizzazione della Produzione Agricola (IRVAM, Rome).

Official data on both national and EEC outbreaks as well as on national vaccination have been kindly supplied by the Direzione Generale dei Servizi Veterinari of the Ministero della Sanità, Rome.

Data analysis

Data analysis has been carried out by a standard CA - Executive Software package on an IBM-PC 5153 computer.

RESULTS AND DISCUSSION

INCIDENCE CYCLES

In the period 1970-1985, CSF outbreaks seem to recur with 4-5 year intervals (Figs. 1A, 1B). The explanation of this cycle, in Italy, appears more complex than that given by Ellis *et al.* (2), who link incidence of CSF in the EEC countries with industry structure modifications due to market variations. The latter do seem to have a certain influence in Italy, as can be seen by comparing the data reported in Figs. 1A and B and in Figs. 2A and B. The epidemic years 1973 and 1977 are preceded by periods of expansion of the Italian swine population. The relationship is particularly evident in 1973 when an increase in the swine population of the entire EEC could be observed. The epidemic of 1983 is preceded by a period of swine population growth which does not appear to be of significance.

In the twelve year period 1970-1981, Veterinary Services in Italy underwent two main reorganisations. In 1970 the provincial veterinary offices, previously attached to the General Veterinary Directorate of the Ministry of Health, passed under regional government jurisdiction and in most cases ceased to exist altogether. In the period 1978-81 the whole Veterinary Service was reorganised with the activation of the so-called Local Sanitary Units. The latter are sub-regional, administratively autonomous units to which the municipal government delegates the management of sanitary services, including veterinary matters. The role played by such changes on the efficacy of veterinary prophylactic measures is unquestionable although impossible to quantify. Indeed, the animal production industry also underwent very marked changes at this time, as can be demonstrated by the following:

1. according to official agricultural censuses (carried out every ten years) the percentage of the Italian swine population in herds of 100 head or more was 48.0% in 1970, and 81.3% in 1982;
2. the number of herds from 1970 to 1982 dropped by 40%, while the total swine population increased by 48.2%;

3. swine imports from 1970 to 1982 increased by 26.9% while pork imports increased 3.4 times;

4. the movement of young stock from central to northern regions ceased almost altogether while the latter became the main internal pig producers and exporters.

There is little doubt, however, that variations in the efficacy of sanitary measures due to changes in both the Veterinary Services and the swine industry can, at least in part, account for the marked differences in epidemiology of CSF observed in geographically adjacent regions.

**Fig. 1**

Incidence of CSF in Italy, 1970-1986
FIG. 2
Swine population in Italy, 1972-1986

GEOGRAPHIC DISTRIBUTION OF OUTBREAKS

Contrary to what has been reported for other EEC countries (2), in Italy no relationship seems to exist between frequency of CSF outbreaks (Figs. 3, 4) and swine population density (Fig. 5), average herd size or breeding herd density, the latter expressed as the percentage of sows in the total swine population (Fig. 6).

In Italy, swine breeding and marketing as well as control measures against CSF differ from those described by Ellis et al. (2) for the rest of the countries belonging to the EEC at that time. It is not surprising, therefore, that the epidemiology of the disease differs too.

Frequency of CSF outbreaks is particularly constant and high in some regions (Figs. 3, 4).
1. Piedmont
2. Valle d’Aosta
3. Lombardy
4. Trentino Alto-Adige
5. Veneto
6. Friuli Venetia Giulia
7. Emilia-Romagna
8. Liguria
9. Tuscany
10. Umbria
11. Latium
12. Marches
13. Abruzzi
14. Molise
15. Campania
16. Basilicata
17. Apulia
18. Calabria
19. Sicily
20. Sardinia

FIG. 3
Regions of Italy
FIG. 4

Number of years in which CSF occurred in Italy, 1970-1986
FIG. 5
Ratio of cumulative CSF outbreaks and average swine population density/km² in Italy, 1970-1985
FIG. 6
Percentage of sows in total swine population in Italian regions, 1983-1985
Sardinia

The disease is endemic and its pattern is likely to be influenced by the same factors that render African swine fever endemic. The main factors are:

a) the very high proportion of sows in the swine population. In Sardinia, taking 1985 as an example, sows represent 26% of the swine population as compared to the national average of 8 sows per 100 pigs;

b) the high incidence of free-ranging pigs facilitates uncontrolled contact among herds and with wild boars, which are known to be infected by CSF virus; the probability of unprocessed swill being fed to swine in rural and pastoral areas is high; the efficacy of Veterinary Service action appears low.

Sicily

In this region too, infection can be considered endemic. In the high hills and mountainous zones free-ranging pig rearing is practised and, therefore, the same conditions described for Sardinia apply. Furthermore, in some areas marketing of swine is still linked to the traditional weekly livestock markets where pigs of various origins are bought and sold.

Campania and Latium

In these regions outbreaks occur with a frequency which is higher than that of other mainland regions, but lower than in Sicily and Sardinia. Both Campania and Latium share some common risk factors. Both regions include large metropolitan areas with a high seasonal presence of tourists. In these areas it is very likely that infection cycles are established in connection with the use of waste food or restaurant offal which has not been heat-treated and with the presence of small herds owned by “part-time” breeders.

Such herds are often not recorded and not subject to veterinary control.

Although Campania does not have a large swine population, it has the highest density of pig herds/km² of all Italian regions. The result is a fragmentation of the swine population into a myriad of small herds which are very difficult to control. In northern Latium, another risk factor is constituted by wild boars which have been found repeatedly to be infected by CSF virus.

The absence of CSF outbreaks in Abruzzi and Molise, regions adjacent to both Latium and Campania, can be explained mainly by two facts: the swine population in the former appears to be the smallest in the country, and the dynamics of swine commerce is such that little if any interchange occurs between the western and eastern regions. This fact also explains the marked differences in disease prevalence observed between Campania in the west and Basilicata and Apulia to the east.

Vaccination coverage is undoubtedly another factor that influences CSF incidence. It is definitely less adequate in the south and the islands than in the centre and the north. It is estimated that in the eleven year period 1974-84, swine present yearly averaged a total of 13 million ± 8%.

Considering the statistics of vaccine doses used in Italy from 1974 to 1985 (Fig. 7) it is obvious that 100% population coverage has never been attained. The percentage
of vaccinations performed in a given area of the country does not reflect the percentage of the swine population in that area.

Considering the year in which the percentages were the most homogeneous (1978), it can be seen that vaccinations performed in the north comprised 74.4% of the total, in the centre 17.7%, in the south 4.6%, in the islands 3.3%, while population percentages in the various zones were respectively 61.6% in the north, 21.0% in the centre, 11.9% in the south and 5.9% in the islands (Fig. 8). Differences in the efficacy of veterinary measures also explain why in some regions CSF spreads more readily. In fact, considering that all CSF virus isolates in Italy, during the 1970-83 period, showed similar pathogenic characteristics, the higher morbidity and mortality rates observed in outbreaks in the southern regions and in the islands are likely to be explained by a lower efficacy of application of veterinary prophylactic measures. In the sixteen remaining regions during the five-year period 1978-82, no outbreaks of CSF were recorded. In 1983, CSF outbreaks in central and northern regions were all secondary to the epidemic in Umbria whose origin will be discussed elsewhere in this paper. Furthermore, from 1970 to 1985 outbreaks of CSF have been recorded outside of the four regions mentioned, only when the disease has assumed an epidemic pattern on a national scale, or has been linked to swill feeding of import origin (as in Bolzano in 1984).

HERDS AT RISK

Data on infected herds size are available only from 1976. Through 1986 the median infected herd size has been: 97 in 1976; 6 in 1977; 8 in 1978; 23 in 1979; 25 in 1981;
18 in 1982; 117 in 1983; 59 in 1984; 25 in 1985 and 23 in 1986. The comparatively high values registered in 1976, 1983 and 1984 are explained by the fact that CSF occurred in the northern provinces and, in 1983, Umbria as well, in zones where both high population density and industrial herds were present. In all the above years, the median size for infected herds was atypical of Italian herd size classes.

Taking 1982 as an example, size classes 3 to 9; 20 to 49; 50 to 99 and 100 to 999 comprise 17.0%, 1.6%, 0.5% and 1.2% respectively of Italian swine herds. In the same year, the percent of total swine population present in the herds of the same classes is 4.5%, 2.9%, 2.1% and 25.9% respectively. One may therefore hypothesise that a risk factor is associated with herd size. The reason for such an association may be that the most frequently affected herds belong to size classes where herds are quite often:

**FIG. 8**

Percentage of swine population by region, 1983-1985
1. "open cycle" operations;
2. family operations or run by part-time breeders (where the level of competence is likely to be insufficient);
3. frequently formed and disbanded according to market fluctuations. They are formed, usually, during periods of swine population growth corresponding to the maximum of CSF infection propagation;
4. formed with pigs often of various origin, by dealers collecting pigs culled by more technically advanced breeders.

INCIDENCE OF CSF IN ITALY AND EEC COUNTRIES

Incidence of CSF in Italy in the years 1970-85 seems to have increased slightly, while in the other EEC countries it decreased markedly (Figs. 1, 9). A more accurate analysis, however, shows that the discrepancy between the trend of the Italian incidence curve and that of the other EEC countries is not as marked as it might appear, for the following reasons:

![Incidence of CSF](image)

**FIG. 9**

Incidence of CSF in the EEC (excluding Italy), 1970-1986
1. The incidence trend in Italy is strongly influenced by the 1977 and 1983 situations. Of the total outbreaks recorded, in 1977, 70% occurred in Calabria, where one finds a very high fragmentation of pig herds. The large number of outbreaks recorded, therefore, is mainly due to the fact that a very high number of small herds became infected in fairly restricted areas; 73% of outbreaks recorded in 1983 occurred in Umbria where infection was clearly connected with a large importation of pigs from abroad. All remaining outbreaks recorded in 1983 in Central and Northern Italy were of secondary importance compared to the Umbrian epidemic;

2. Although from 1970 to 1985 the general incidence trend in the EEC is downward, from 1976 one can see a clear tendency towards increasing outbreaks;

3. A statistically significant ($P > 0.05$) correlation exists between incidence of disease in Italy and in Holland, which supplies the majority of swine and pork imported into Italy (Figs. 10, 11);

![Swine imports into Italy from EEC countries, 1970-1984](FIG. 10)

![Fresh and frozen pork imports into Italy from EEC countries, 1970-1984](FIG. 11)
4. the risk of introduction of infection in Italy from abroad increased continuously from 1970 to 1983 (particularly in the last three years). In fact, Italian imports of swine and pork have increased in recent years along with incidence of the disease in most of the EEC exporting countries;

5. the annual epidemiological cycle of CSF in Italy and in the EEC countries shows a significant correlation, as will be explained in the following paragraph.

SEASONAL CYCLE

The incidence curve per month (Fig. 12) can be explained by the dynamics of certain swine population categories (Figs. 13, 14).

Incidence peaks seen in February, April and August are probably due to risk factors that act together or in isolation, namely:

1. the highest concentration and movements of weaned pigs, the category most susceptible to CSF infection (65% of affected animals in the 1983 Umbrian epidemic belonged to this category), occur in late spring and early summer;

2. fattening pigs imported in the spring and in early summer come mainly from countries where the highest incidence of CSF occurs in the period which immediately precedes exportation to Italy;

3. the highest percentage of farrowing and in particular of farrowing gilts occurs in spring;

![Seasonal pattern of CSF in Italy, 1976-1986, by month](image)

FIG. 12

Seasonal pattern of CSF in Italy, 1976-1986, by month
FIG. 13
Percentage of piglets and 20-50 kg pigs in total swine population of Italy, 1972-1984

FIG. 14
Percentage of gilts in total sow population of Italy, 1972-1984

4. at the beginning of summer, the holiday period begins (maximum in August). During this period there is a reduction in available animal disease control personnel along with peak consumption of domestic and imported pork in the zones where tourist movement is most intensive (the same where CSF appears most frequently);
5. the probability of movement of unvaccinated animals is greatest during the period of maximum CSF incidence. Data on vaccination show that application is constant throughout the year.

Considering that population cycles obey a seasonal pattern, it is obvious that in those periods (spring and early summer) when the population of weaned pigs is at a peak (in Italy present regulations provide for vaccination of pigs for the first time at 60 days of age or at the time of exit from the herd of origin), the probability of movement of young unvaccinated pigs will be higher than in other periods.

CONCLUSIONS

The epidemiology of CSF in Italy in the period from 1970 to 1986 is characterised by:

1. a pluriannual cycle showing three epidemic peaks due to a group of risk factors. Whether identifiable or hypothetical (on the basis of circumstantial data) such risk elements include the following:
   
   a) dynamics of the Italian pig population as well as that of the main exporting countries to Italy of pigs and pork;
   
   b) epidemiological pattern of swine fever in EEC countries, especially those that export to Italy the highest number of pigs and the largest amount of pork;
   
   c) slackening of vaccination and sanitary measures due to the extended absence of disease in the areas with highest swine density. It is particularly dangerous that farmers in some regions are convinced that the vaccination of pregnant sows is risky. In this connection, it is worth mentioning that in 1970, when one of the lowest frequencies of CSF outbreaks was reported, the percentage of vaccinated swine was about 60%. In addition, it should be noted that in the previous three years the measures of direct prophylaxis were strictly applied as never before (or since), as evidenced by the eradication of African swine fever;

2. endemic state of infection in Sicily and Sardinia where environmental conditions and breeding and marketing systems are unique;

3. high-risk areas that can be identified, in addition to the islands mentioned above, in the regions of the central and southern Tyrrenhian coast, namely Latium, Campania and Calabria. In these regions the prevalence of CSF is higher than in the rest of the country. An hypothesis can be adduced to explain the different frequency of infection, but this should be confirmed by ad hoc epidemiological investigation;

4. the absence of infection in the breeding stock of the regions that produce the most feeder pigs. This is demonstrated, indirectly, by the fact that in some of the regions which are net importers of fattening piglets, the disease has been absent in the last fourteen years. Furthermore, when CSF appeared in 1983 in Umbria (one of the main producers of piglets), the infection appeared and was promptly recognised in regions which had been free of the disease for the previous thirteen years;

5. the frequency of disease in herds of certain size classes. In these herds a small minority of Italian swine are found. The management characteristics of these herds and the difficulty of placing them under veterinary control could be the cause that renders these types of herds more prone to infection;
6. morbidity rates which differ in the various geographic areas of the country. These differences are probably due to varying efficacy and promptness of application of vaccination and sanitary measures.

The pattern of disease and the characteristics of swine fever infection in Italy therefore cannot be viewed in the epidemiological perspective reported for other EEC countries and which constitutes the basis of the eradication plan mentioned in EEC Directive 80/1095. Italy, according to the above directive, has planned an eradication programme (Ordinances of the Ministry of Health, dated 25.02.83 and 10.02.84) which calls for the gradual phasing out of vaccination within a five year period on all national territory. Taking into account the swine fever situation in Italy, the successful accomplishment of the eradication plan depends on:

i) prevalence and incidence of CSF in countries exporting swine and pork to Italy;

ii) adoption of control measures according to the different epidemiological patterns of infection in the country;

iii) capability of reinforcing the sanitary measures, particularly where vaccination will be suspended. Accurate census data concerning both herd sizes and distribution as well as management characteristics will be necessary;

iv) the firm intervention of sanitary authorities in order to assure that vaccination is carried out in districts where it is still needed, and according to the dynamics of the swine population;

v) interruption of any derogation from slaughtering of animals where outbreaks occur;

vi) tracing and clarifying of the epidemiological cycle of infection both in regions where it is endemic and where it occurs more frequently than elsewhere;

vii) sanitary control of imported animals. Either direct access by each EEC Veterinary Service to computer-stored CSF information collected by the EEC Commission according to Directive 82/894 or at least the compilation and publication of exhaustive periodical reports on CSF epidemiology by the Commission based on the same information, would be of great value for CSF control in the EEC. Furthermore, a monitoring system for the sanitary condition of imports, based on casual sampling with established confidence levels, appears essential;

viii) establishment of a continuous surveillance system using some indicators, as partly specified in this work, which could detect high risk situations;

ix) establishment of a quality control programme for diagnostic laboratories which have the responsibility for CSF diagnosis;

x) modification of the legislation concerning veterinary emergencies and particularly the occurrence of disease with an epidemic pattern.

Recent experience shows the necessity of:

a) preparing operative plans to carry out the slaughter and destruction of animals during outbreaks, which can be immediately applied when requested, especially in regions with high density of animal and/or human population;

b) guaranteeing that full compensation payments for destroyed animals can be made promptly;
c) controlling the application of prophylactic measures as well as of veterinary policy regulations;

d) increasing the level of epidemiological investigations, in general and of those connected to CSF, in particular. To correct this situation it would be sufficient to call upon personnel from Reference Centres to direct epidemiological investigations in the event of an outbreak;

e) strengthening information and education programmes for veterinary personnel and breeders, regarding the application of measures against CSF.

It should be stressed, finally, that a successful eradication programme must take into account the dynamics of swine populations, especially in relation to both animal movements, which appear to have little if any relation to traditional administrative boundaries, and herd structure and management which appear to be rather peculiar and difficult to classify in a few standard classes. Nevertheless, prophylactic plans are still organised according to the assumption of the existence of homogeneous herd management classes and following the traditional administrative boundaries.

Eradication efforts would have a much better chance of succeeding if planning and management would take as their main point of reference, not the administrative limits, but rather the swine commercial traffic basins which, at present, are not fully characterised from either a qualitative or quantitative point of view. Furthermore, classification of herds into standard types whose definition appears problematic does not seem advisable.

It would thus seem appropriate to plan an eradication campaign based upon a strategy of sanitary accreditation of individual herds, with strict regulation of movement so that animal exchanges are carried on only between herds of comparable health status.

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Résumé : L'épidémiologie de la peste porcine classique (PPC) en Italie est analysée afin d'évaluer la probabilité de la réussite des actions menées pour sa prophylaxie. Alors que la majeure partie de la population porcine se trouve dans le nord du pays, la prévalence de la maladie est beaucoup plus élevée dans le sud, plus particulièrement en Sardaigne et en Sicile. En Italie, la PPC a une incidence saisonnière, avec un pic en août et des pics moins importants en février et en avril. Cependant, la vaccination est pratiquée de façon continue tout au long de l'année, sans tenir compte du nombre accru des animaux sensibles au cours des mois en question. L'incidence de la PPC est en augmentation dans la plupart des pays de la CEE, qui sont les principaux fournisseurs des porcs vivants et de la viande de porc importés par l'Italie.


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Resumen: Se analiza la epidemiología de la peste porcina clásica (PPC) en Italia con objeto de evaluar la probabilidad de éxito de las acciones llevadas a cabo para su control. Mientras la mayor parte de la población porcina se encuentra en el norte del país, la prevalencia de la enfermedad es mucho mayor en el sur, especialmente en Cerdeña y Sicilia. En Italia, la PPC es estacional, con una incidencia punta en agosto y picos menos elevados en febrero y abril. Sin embargo, la vacunación se practica de manera continua durante todo el año, sin tomar en cuenta el mayor número de animales sensibles en los incriminados meses. La incidencia de la PPC está en aumento en la mayoría de países de la CEE, que son los principales proveedores de cerdos vivos y de carne de cerdo importados por Italia.

PALABRAS CLAVE: Control - Enfermedades de los cerdos - Enfermedades virales - Epidemiología - Italia - Vacunación - Virus de la peste porcina.

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REFERENCES


