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IMPLEMENTATION OF A VETERINARY GEOGRAPHICAL INFORMATION SYSTEM IN THE ABRUZZI REGION

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Les objectifs de ce travail étaient de montrer le fonctionnement d'un système d'information géographique (GIS) dans la région des Abruzzes en Italie, puis d'utiliser les statistiques spatiales pour vérifier la présence de facteurs de risque pour la Brucellose Bovine (BBr). Le GIS permet de cartographier et de localiser les phénomènes, alors que les méthodes statistiques univariées, multivariées, et spatiales permettent leur analyse et l'estimation d'indicateurs.

Sur un ensemble de 74.990 élevages suivis pendant 12 ans (1982-1993), un groupe de 18.763 d'entre eux a été considéré pour l'étude. Parmi ces derniers, les auteurs ont sélectionné 6.656 têtes (dont 2.433 infectées), en vue d'une étude cas-témoin.

L'index de l'autocorrélation spatiale de Moran montre l'existence d'un regroupement des prévalences moyennes de BBr à l'échelle communale (Z_I = 6.11). Le regroupement était plus marqué dans les collines de l'intérieur de la région, où la densité des élevage est basse et le pâturage est plus fréquent. La prévalence moyenne des élevages et des animaux durant toute l'étude (1982-1993) était corrélée au pourcentage de terre réservée au pâturage au sein de chaque municipalité (élevage : coefficient de corrélation de Spearman r_s = 0.29, p<0.01 ; animal : r_s = 0.27, p<0.01). La prévalence moyenne des élevages et animaux infectés variait significativement selon la localité (élevage : analyse de variance avec Kruskall-Wallis χ^2 = 83.62, p<0.01 ; têtes : χ^2 = 78.34, p<0.01). Les variables associées significativement au statut de l'animal ressorties par l'étude cas-témoin étaient : l'origine de l'animal (χ^2 = 116.51, p<0.01), le sexe (χ^2 = 33.39, p<0.01), la race (χ^2 = 127.6, p<0.01), l'âge avancé des animaux (Mann-Whitney U, z_u = 11.87), et la taille de l'élevage (Mann-Whitney U, z_u = 8.10). En conclusion, les régions intérieures à pâturage, l'origine autochtone des animaux, les animaux âgés et la taille des élevages semblent être les facteurs de risque pour la BBr.

INTRODUCTION

Geographical Information Systems (GIS) in Italy have been applied mainly to the study of wildlife populations ecology. GIS are, on the contrary, seldom used in Veterinary Public Health despite their indisputable usefulness in the description and analysis of epidemiological data.

Aim of this work is to report the results obtained implementing GIS to analyze risk factors influencing the occurrence of Bovine Brucellosis (BBr) in an Italian Region.

MATERIALS AND METHODS

A total of 74.990 herd testing, carried out in 18.763 bovine herds, over a 12 year period (1982-1993), were analyzed. Testing was carried out on 100% of herds present in each Municipality (the smallest territorial unit in the Italian administrative legislation) of the Region. Within each herd 100% of the animal present were tested. A Municipality has been considered infected when at least one infected herd was present in its territory. Statistical significance of clusters has been analyzed for the entire period by BW index of the statistic "join count". This index is based on calculation of both the total number of shared borders among Municipalities and the comparison between the number of the adjacent discordant Municipalities (infected/not infected) and the expected number of adjacent discordant Municipalities, assuming randomness of spatial distribution of the infection. The spatial index Moran's I was used to determine if BBr prevalence clusters in adjacent Municipalities. The mean prevalence of both infected herds and infected animals in different Municipalities, over the 1982-1993 period, has been compared (i) with the percentage of their territory used for grazing by the Spearman non-parametric correlation coefficient; (ii) among Local Health Units (ULS) (territory served by each Local veterinary service, comprising several Municipalities) by the Kruskal-Wallis non-parametric one-way analysis of variance. The mean prevalence of both infected herds and infected animals in the different ULS, over the 1982-1993 period, has been compared with the mean number of days between herd controls in both negative and positive herds by the Spearman non-parametric correlation coefficient.

A case-control study was carried out to analyze risk factors by traditional statistical tools and included 6.656 animals. Of these 2.433 were cases, 94,3% were females and 86,8% were dairy.

The distribution of the BBr for sex, breed, geographical origin has been analyzed by the Chi-square test, while the effect of age and herd size has been analyzed by Mann-Whitney U test. Finally, the multivariate logistic regression has been used to determine the effect of the variables defined as relevant following the univariate indexes and to calculate odds ratios. Calculations have been performed using the SPSS software for Windows.

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FIGURE 1- LOCATION OF CATTLE HERDS IN THE ABRUZZI REGION (1995 CENSUS)

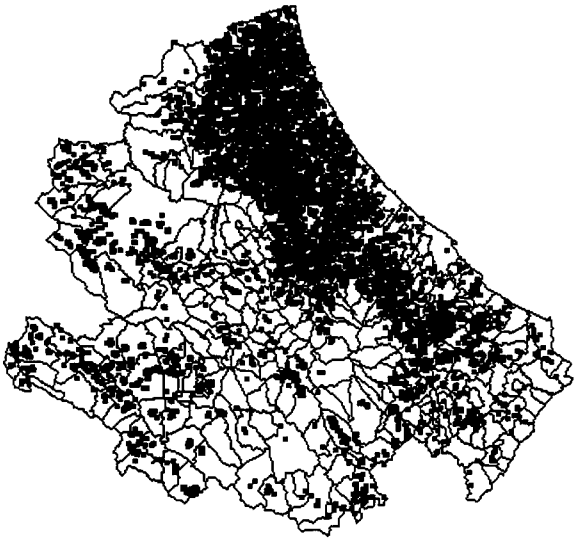


FIGURE 2 - MEAN PREVALENCE OF INFECTED HERDS DURING THE 1982-1993 PERIOD IN THE ABRUZZI REGION MUNICIPALITIES

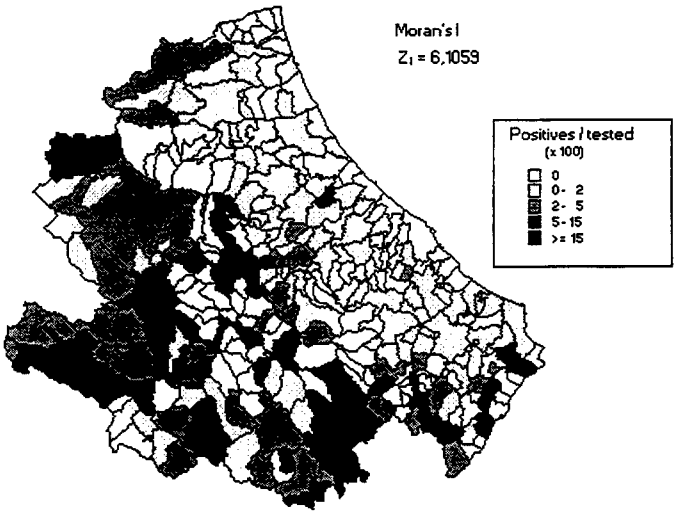
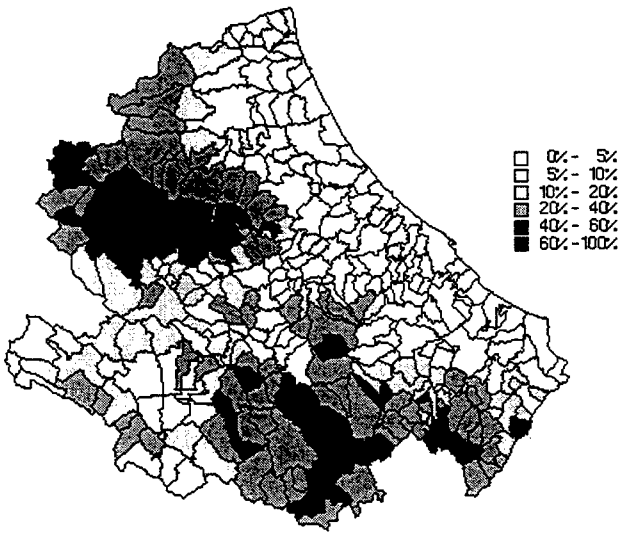


FIGURE 3 - PERCENTAGE OF PASTURE AREA IN THE ABRUZZI REGION MUNICIPALITIES



RESULTS

The distribution of the 8.061 cattle herds in the Abruzzi Region is shown in Figure 1; the value of the spatial autocorrelation index for BBr prevalence in the Abruzzi (Z_I=6.11, P< 0.01) is shown in Figure 2. Infection clustering was mainly located in the western part of the Region, where herd density is lower and grazing is more frequent (Figure 3).

Prevalence of both infected herds (K-W χ^2=83.62, P<0.0001) and infected animals (K-W χ^2=78.34, P<0.0001) varies significantly in the various ULS. The percentage of the Municipal territory dedicated to grazing shows a statistical association with BBr prevalence in both animals (r_s=0.266, P<0.0001) and herds (r_s=0.286, P<0.001). The association is stronger, for both animals(r_s=0.351, P<0.0001) and herds (r_s=0.411, P<0.0001) if only the Municipalities with at least one infected herd during the period are taken into account.

The mean time interval between controls was not correlated to infected herd prevalence, in case of positive herds within each ULS (r_s=-0.075, P=0.791), while it was negatively correlated to infected herd prevalence in the different ULSS in case of negative herds (r_s=-0.746, P=0.001). A possible explanation is that the time between controls, did not influence the spread of the disease, while the high prevalence of infected herds, stimulated an increase control frequency. This phenomenon is also observed in case of animal prevalence (controls in the positive herds, r_s=-0.004, P=0.990; controls in the negative herds, r_s=-0.743, P=0.002).

Risk of BBr infection in animals of Regional origin is 4 times that of animals originating from either other Italian Regions or abroad (χ^2=116.51, P<0.00001); female risk is about 3 times higher than male (χ^2=33.39, P<0.00001). Brown Swiss, Marchigiana and crossbred (χ^2=127.60, P<0.00001) have a higher risk of being infected compared to other breed, while dairy and non-dairy breed share the same risk level. Age (Z_U=11.87, P<0.0001) and herd size (Z_U=8.10, P<0.0001) have a positive association with infection status (Table 1).

The multiple logistic regression failed to generate an acceptable model for the risk factors examined. Only univariate results were, therefore, taken into account.

TABLE 1 - RISK FACTORS , ODDS RATIOS AND RELATED CONFIDENCE INTERVALS

Variable	Odds Ratio	95% Confidence interval	
Age (>5 years vs. <=5 years)	1.46	1.32	1.62
Herd size (>15 heads vs. <=15 heads)	1.48	1.34	1.63
Sex (female vs. male)	3.12	2.09	4.65
Origin (regional vs. extra-regional)	4.41	3.30	5.88

DISCUSSION

The results obtained confirm that GIS is a very useful tool in veterinary public health actions management, as reported previously.

The highest infection occurrence in the western part of the Region, where grazing is more frequent, is consistent with the correlation observed between the percentage of the Municipal territory used for grazing and BBr prevalence. Grazing, under the conditions encountered in the Abruzzi, appears to be an important risk factor for BBr. The significance of husbandry methods as risk factor appear to be confirmed by the higher prevalence observed in animals of regional origin vs. imported ones, and the high frequency of infection in local breed.

Results of this study differ considerably from those of a previous study on Bovine Tubercolosis (BTb) epidemiology in the same population, carried out using a similar methodology. In the case of BTb a number of features associated with intensive husbandry methods seemed to play a role as risk factors: infection was more frequent in dairy breeds, mainly in Holstein, while the percentage of the municipal territory dedicated to pasture did not influence infection occurrence. Infection was also more frequent in animals imported from other Italian Regions than in the indigenous ones.

In conclusion, the methodology used in this study allows the detection and the quantification of risk factors that specifically act on a disease in a given geographical area. It induces, furthermore, to some thoughts about eradication strategy for BBr and BTb currently implemented. The epidemiology of the two diseases appear to differ significantly in the population, while control strategies adopted in the Italian legislation, at present, are practically the same.

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