

Spatial analysis of risk of sheep and goats brucellosis in Sicily from 2001 to 2006

Analisi Spaziale del rischio di Brucellosi ovi-caprina in Sicilia dal 2001 al 2006

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Riassunto: L'analisi spaziale sta assumendo un ruolo sempre più importante nel contesto dell'analisi del rischio di malattia. In questo lavoro viene descritta la distribuzione spaziale della prevalenza della Brucellosi ovi-caprina in Sicilia nel periodo 2001-2006 per individuare le zone che presentano un maggior rischio di malattia.

Keywords: Spatial statistics; Clusters; inhomogeneous Poisson process

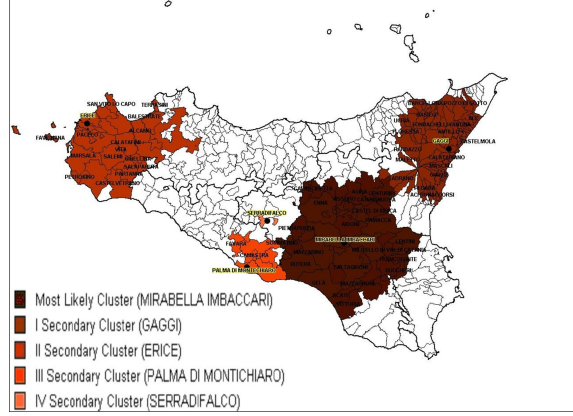
1. Introduction

Spatial analysis is playing an increasingly important role in the context of risk analysis of disease because of its ability to provide immediate visualization of information on the phenomenon being studied. In this work space analysis was performed using *scan statistics* to test whether a point process is purely random or whether any structure can be detected. In particular we used a method (the so-called *quadrat method*) that identifies possible clusters of disease and the locations of these clusters in a population with inhomogeneous spatial density.

2. Application

We considered the region Sicily partitioned into cells corresponding to municipalities. For each municipality we obtained the coordinates of the geographical centroid, the number of flocks and the number of cases of disease. We created circular windows on the area, identifying each municipality as the center of the circle, called the centroid; we then included a progressively larger number of municipalities surrounding the centroid by increasing the radius from zero to an upper limit corresponding to prevalence. Finally we identified clusters among the circles. In all six years of the study, some areas of the region were identified as clusters in which there was a major risk in terms of prevalence of brucellosis. In particular, cluster analysis showed that during the period under investigation 21 municipalities displayed a constant level of risk. The clusters obtained are shown in figure 1. The risk of disease may occur throughout the region so there are no subsets

Figure 1: *Clusters of highest risk of brucellosis in Sicily year 2006*



with major risk. This way we can analyze the phenomenon under the Poisson model and consider points generated by an inhomogeneous Poisson process. We let G be the geographical space (Sicily region) and Z the set of all circular zones $z \subset G$ (Kulldorff, 1997). We consider a point (z, p, q) in the parameter space where p, q vary from 0 to 1 and z is used on the one hand to denote a vector made by the centroid coordinates and the radius of circle and on the other hand to denote the zone it describes. In each circular zone z let p be the probability of a case occurring in the municipalities inside z and q the probability of a case occurring in the municipalities outside z , in order to constructed a hypothesis system (Kulldorff and Nagarwalla, 1995):

$$\begin{aligned} H_0 &: p = q \\ H_1 &: p > q \end{aligned}$$

To test the hypothesis system we use the likelihood ratio test (LRT):

$$\lambda = \left(\frac{c(z)}{n(z)} \right)^{c(z)} \left[\frac{C - c(z)}{C - n(z)} \right]^{C - c(z)} \quad (1)$$

where C is the total number of cases observed in the region, $c(z)$ is the number of cases inside the circular window z and $n(z)$ is the expected number of cases inside the circular window z . The window with maximum likelihood can be defined as the most likely cluster. The likelihood ratio for this window constitutes the maximum likelihood ratio test statistic. In order to compare the maximum likelihood from the random data sets generated under null hypothesis with the maximum likelihood from the real data set we used Monte Carlo hypothesis testing (Kulldorff *et al.*, 2003).

References

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