

# There is a Geographical Area of Extreme Longevity (*Blue Zone*) in Sardinia?

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KEY WORDS: longevity, centenarians, Sardinia.

## Introduction

One of the most important demographic phenomena occurring in industrialized countries since mid-last century is a progressive increase of life expectancy (Oeppen and Vaupel, 2002; Candore *et al.*, 2006).

In the Italian context several studies about centenarians have been carried out (Caselli *et al.*, 2000; Passarino *et al.*, 2002; Guerresi *et al.*, 2003; Magnolfi *et al.*, 2007), particularly regarding the insular region of Sardinia (Deiana *et al.*, 1999; Poulain *et al.*, 2004), where a high level of longevity index (number of centenarians / population) has been reported in the Italian National Census 1991: 13.6 centenarians every 100,000 inhabitants, with a maximum in Nuoro Province (24.35) and a minimum in Cagliari (9.7), vs. an Italian average value of 7.6. Ten years later, in Italian Census 2001, the longevity rates became much higher: 16.6 centenarians every 100,000 people, with a maximum in Nuoro (17.9) and a minimum in Cagliari (8.4). The Italian average value of longevity index was equal to 14.1 (Deiana *et al.*, 1999; Poulain *et al.*, 2004).

As stated by Poulain *et al.* (2004), Sardinian centenarians are not homogeneously distributed over regional territory. On the basis of a particular index (ELI: *Extreme Longevity Index*), defined as the percentage of people born in Sardinia from 1880 to 1900, who lived more than 100 years, and by a multiscalar smoothing method based on Gaussian neighborhood distribution that allows the study of the spatial concentration of centenarians as a continuum, a *Blue Zone* (BZ) has been individuated, which seems characterized by a high concentration of longevity. The main aim of the present study is to verify the presence and persistence of a high-longevity area in Sardinia.

## Materials and Methods

Our data comes from ISTAT (Italian National Institute of Statistics), covering the Census 2001, and the Inter-census estimation done in 1992 and 2010. From this data it is possible to recompose the distribution by sex and age of municipal population.

To make a comparison between the rate of centenarians in Sardinia and the other Italian regions the Longevity Index (LI) has been used, derived by comparing the number of centenarians with total population. Such index has been standardized for historic-geographical zones of Sardinia considering Inter-census estimation 1992 e 2010 and Census 2001.

Longevity Index (LI) as follows:

$$LI = (n_{100}/N) * 10000$$

$n_{100}$  = number of centenarians

$N$  = population

Finally, to evaluate whether the number of municipalities with presence of centenarians is actually greater than expected, we applied Poisson distribution to municipalities with a population less or equal to 2500 people.

## Results

In Figure 1 we represented the 34 historic-geographical zones of Sardinia (Ghiani Moi, 1964). For each zone, Longevity Index value has been showed for Inter Census revision 1992, for Census 2001 and Inter-census estimation 2010. In Table 1, for every Census and Inter Census year, Poisson distribution results have been reported.

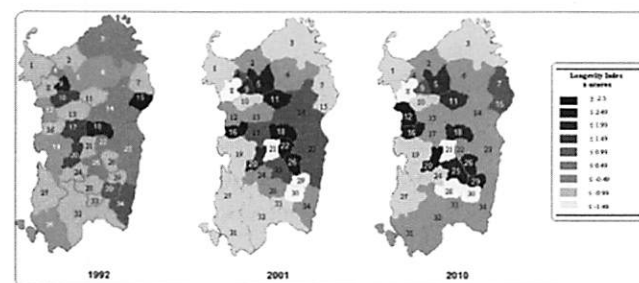


Fig. 1. Standardized Longevity Index (z-scores) in the historic-geographical zones of Sardinia in the Census and Inter-census years considered.

## Discussion

On the basis of our results, it seems that no one of the 34 historic-geographical zones presents a LI value always greater than other parts of Sardinia. Nevertheless, it is

	Centenarians in each municipality	N. of municipalities: Observed	N. of municipalities: Expected
1992	0	206	204.5
	1	21	24.0
	2	3	1.4
	3	0	0.1
	Centenarians in each municipality	N. of municipalities: Observed	N. of municipalities: Expected
2001	0	192	196.3
	1	38	39.4
	2	8	4.0
	3	2	0.3
	Centenarians in each municipality	N. of municipalities: Observed	N. of municipalities: Expected
2010	0	167	158.4
	1	52	67.8
	2	20	14.5
	3	4	2.1

Tab. 1. Poisson distribution for municipalities less than 2500 inhabitants: number of municipalities (observed and expected) with 0, 1, 2, 3 or more centenarians, in the years considered.

interesting that the historic-geographical zone of "Barbagia di Ollolai" has the highest value both in 1992 and 2001. Such a result, which seems to indicate for the above mentioned zone a tendency to extreme longevity, should be checked carefully with the aid of other indices. Moreover, the Poisson distribution results do suggest a random distribution of the number of centenarians among the small municipalities (less than 2500 inhab). Finally, to validate these results, we consider the opportunity of a further evaluation of the spatial distribution of longevity in Sardinia, even analysing the sex ratio F/M.

## References

- Candore G., Balistreri C.R., Listi F., Grimaldi M.P., Vasto S., Colonna-Romano G., Franceschi C., Lio D., Caselli G., Caruso C., 2006. Immunogenetics, Gender, and Longevity. *Ann. NY Acad. Sci.*, 1089: 516-537.
- Caselli G., Vaupel J.W., Yashin A.I. 2000. Longevity, Heterogeneity, and Selection, *Atti XL Riunione Scientifica della Società Italiana di Statistica*, SIS, Firenze: 49-69.
- Deiana L., Ferrucci L., Pes G.M., Carru C., Delitala G., Ganau A., Mariotti S., Nieddu A., Pettinato S., Putzu P., Franceschi C., Baggio G. 1999. AKEntAnnos. The Sardinian study of extreme longevity. *Aging Clin. Exp. Res.*, 11: 142-149.
- Ghiani-Moi P. 1964. *Sardegna d'oggi*. La Poliedrica, Roma.
- Oeppen J., Vaupel J.W. 2002. Demography. Broken limits to life expectancy. *Science*, 296 (5570): 1029-1031.
- Gueresi P., Troiano L., Minicuci N., Bonafè M., Pini G., Salvioli G., Carani C., Ferrucci L., Spazzafumo L., Olivieri F., Cavrini G., Valentini D., Franceschi C. 2003. The MALVA (MAntova LongeVA) study: an investigation on people 98 years of age and over in a province of Northern Italy. *Exp Gerontol.*, 38: 1189-1197.
- Magnolfi S.U., Petrucci E., Pinzani P., Malentacchi F., Pazzagli M., Antonini F.M. 2007. Longevity index (LI%) and centenarity index (CI%): new indicators to evaluate the characteristics of aging process in the Italian population. *Arch. Gerontol. Geriat.*, 44: 271-276.
- Passarino G., Calignano C., Vallone A., Franceschi C., Jeune B., Robine J.M., Yashin A.I., Cavalli Sforza L.L., De Benedictis G. 2002. Male/female ratio in centenarians: a possible role played by population genetic structure. *Exp. Gerontol.*, 37: 1283-1289.
- Poullain M., Pes G.M., Grasland C., Carru C., Ferrucci L., Baggio G., Franceschi C., Deiana L. 2004. Identification of a geographic area characterized by extreme longevity in the Sardinia island: the AKEA study. *Exp. Gerontol.*, 39: 1423-1429.