

Is sex ratio at birth changing in Italy? Spatial and temporal trends' analysis.

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Introduction and aim of the study

In societies where no prenatal sex selection have been observed, male to female ratio at birth (secondary sex ratio) is commonly assumed to be relatively stable and it averages between 105 and 106 boys per 100 girls.

Notwithstanding, some recent studies showed that in the last decades there has been a slightly but significant change in this ratio both considering Countries as whole and regions or small areas. According to Davis and colleagues (1998), a declining trend can be observed in Denmark, the Netherlands, Canada and US, whereas a comparative research carried out in 29 Countries reveals mixed results (Parazzini *et al*, 1998): between 1950 and 1994 the sex ratio shifted downwards in 16 countries, whereas it increased in 6 and remained roughly stable in the other 7. South Europe (including Italy) is one of the areas where the rise of sex ratio has been observed. Moreover, Astolfi and Zonta (1999) reported that during 1970-1997 the proportion of male births has significantly declined in the four most populated Italian provinces, while the opposite trend can be noted in the rest of the country. This means that aggregate national trend can obscure important variations in sex ratio across regions and, in general, across sub-national areas.

The sex of newborns is dictated by biological and genetic factors. At the same time studies show that there are various exogenous factors that can affect them and consequently lead to an upward/downward of the male to female ratio at birth at an aggregate level. Summing up, it was hypothesized that sex ratio can be affected by:

- *Maternal and paternal age*: it was found that the more parents are old the higher are their chance of giving birth a baby girl (Hytttem and Leitch, 1971; Ruder, 1985);
- The *number of children* a woman has in her lifetime: parity is negatively associated with sex ratio (Roston and James, 1977; Federici, 1979; James, 1998);
- *Ovulation induction and assisted reproduction* also decrease the proportion of male births (James, 1985 e 1987; Beiguelman *et al*, 1995);
- *Living standards and quality of medical care*: their improvement positively affect offspring sex ratio because they lead to a decrease of prenatal mortality that affects more male than female fetus (Astolfi e Zonta, 1999);
- *Socio-economic status* (SES): similarly, it has been observed that high SES individual/couples have a higher chance to give birth a baby boy if compared with the one of total population (Teitelbaum e Mantel, 1971);

- *Environmental factors*: many studies were devoted to clarify the relation between pollution and sex ratio at birth, but the results are controversial. Yang and colleagues (2000) found a significantly higher proportion of male births in the areas where petrochemical industries are located. Although, the same authors noticed that previous studies have led to different conclusions. In those researches sex ratio is still significantly sensitive to the polluting agents whose effects were tested, but in the other way round: that is, in more polluted areas were registered abnormally low male to female ratio at birth (Mocarelli *et al*, 1996; Møller, 1996; Weisskopf *et al*, 2003). Further, some scholars consider the relationship between pollution and sex ratio so unequivocal that they suggest to use the proportion of male births as a “sentinel health indicator” that deserves to be continuously monitored (Lyster, 1973; Hytten, 1982; Davis *et al*, 1998). Conversely, other researchers found that there is a clear connection between mortality and air pollution, but no relation can be traced between the latter and the sex ratio at birth (Williams *et al* 1995).

The research questions we want to answer are as follows: is sex ratio at birth changed in the last decades in Italy? Is it possible to detect areas where the male to female ratio significantly differ from the one registered for the population as a whole? Sex ratio at birth is naturally prone to fluctuations: the spatial and temporal trends we observe in Italy are statistically significant or – as some scholars suggest (Dodds and Armson, 1997; James, 1997) – due to mere chance? Which variables are associated with unusual sex ratio at birth? Which are the demographic consequences of that (eventual) change? Summing up, the aim of our study is to analyse temporal trend not only for Italy as a whole but also for smaller areas by considering explicitly the impact of the main demographic variables connected with reproductive behaviour, socioeconomic conditions and air pollution.

Data and Method

For the empirical analyses, data from Population Registers are used. This data source is therefore an administrative one, and consists of the list of all the births recorded in Italy during the period under study. It gives information on the main characteristics of births (sex, date and place of birth, nationality) and parents (date and place of birth, nationality, marital status) at municipal level. Moreover in Italy birth registration began in 1862 so that an extremely extended time series can be analysed. However, the present research focuses on the period between the end of Sixties and 2008, the last year available.

From a spatial point of view, we consider the sex ratio’s temporal trends at national, regional and sub-regional level. Our aim is to identify geographic clusters of significantly and persistently high or low male to female ratio if compared with the national value. Note that operating at a more refined geographic detail provides new insights into the topic, but at the same time it introduces more complex statistical problems associated with small population size that must be considered (i.e. random fluctuations).

The effect of demographic variables (such as total fertility rate, mean age at childbearing, ...) on sex ratio at birth are carefully examined after controlling for (local) population size. Environmental factors are considered by many scholars to be crucial in understanding the recent trend in offspring sex ratio. However, in Italy no accurate data on air pollution are available at sub national level: for this reasons regional and provincial data on mortality for specific causes of death will be used as proxy variables since many scholars have pointed out the connection between air quality and standardized mortality rates for selected causes (Lloyd *et al*, 1984; Williams *et al*, 1995).

From a statistical point of you, 1-level mixed Poisson regressions are estimated to disentangle the effects of demographic and health variables on sex ratio at birth.

Results are presented by largely using several tools for reading geographic data, such as thematic maps.

As well as in other studies where the unit of analysis is a population rather than an individual, caution is needed in the interpretation of the results due to ecological fallacy. Moreover more detailed information on environmental factors at sub national level will be very needed and helpful. Despite this limitations, the present study offers a comprehensive overview of spatial and temporal trends in sex ratios at births in Italy by controlling for demographic variables. Moreover the results can encourage further studies on this topic.

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