LONG-TERM MORTALITY IN A RESIDENTIAL COHORT EXPOSED TO INORGANIC HEXAVALENT SELENIUM THROUGH DRINKING WATER

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Background and aims

Very limited evidence is available on the health effects of the selenium found in drinking water, due to the extremely small number of studies. Furthermore, evidence from human investigations on dietary (organic) selenium is of limited relevance when assessing this issue, due to the distinctive toxicological and nutritional properties of the inorganic species of this element generally found in drinking water.

Methods

In the present study, we further extended a retrospective follow-up of a cohort of 2065 residents in the Reggio Emilia municipality, who had inadvertently been consuming since 1974 until 1985 tapwater with unusually high content of hexavalent selenium (selenate, around 8 µg/Se/l), while selenium levels in the remaining part of the municipality was substantially undetectable (detection limit 0.2 µg/l). We evaluated mortality from major causes, from some specific cancers, and from neurodegenerative disease in the 1986-2012 period, which we further split into two time windows, 1986-1997 and 1998-2012. We compared the causes of death of cohort members with those of the remaining municipal residents also continuously residing in the community since 1974 until 1985, adjusting for age and gender.

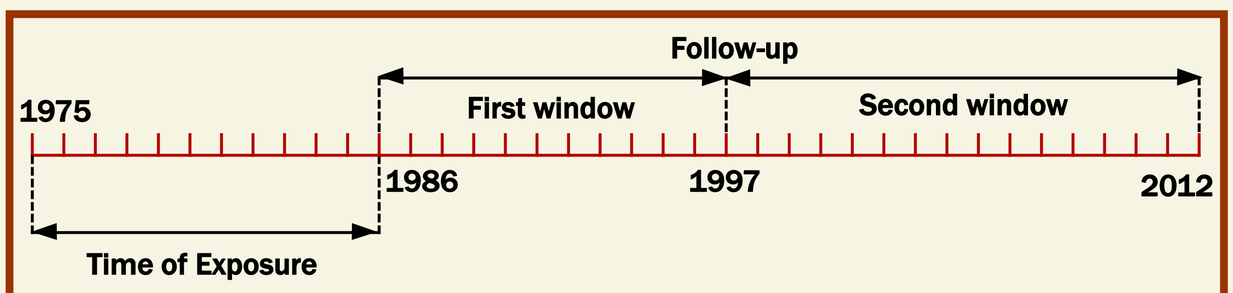

Figure 1. Design of the retrospective cohort study, which involved 2,065 residents of Reggio Emilia exposed to hexavalent inorganic selenium through drinking water.

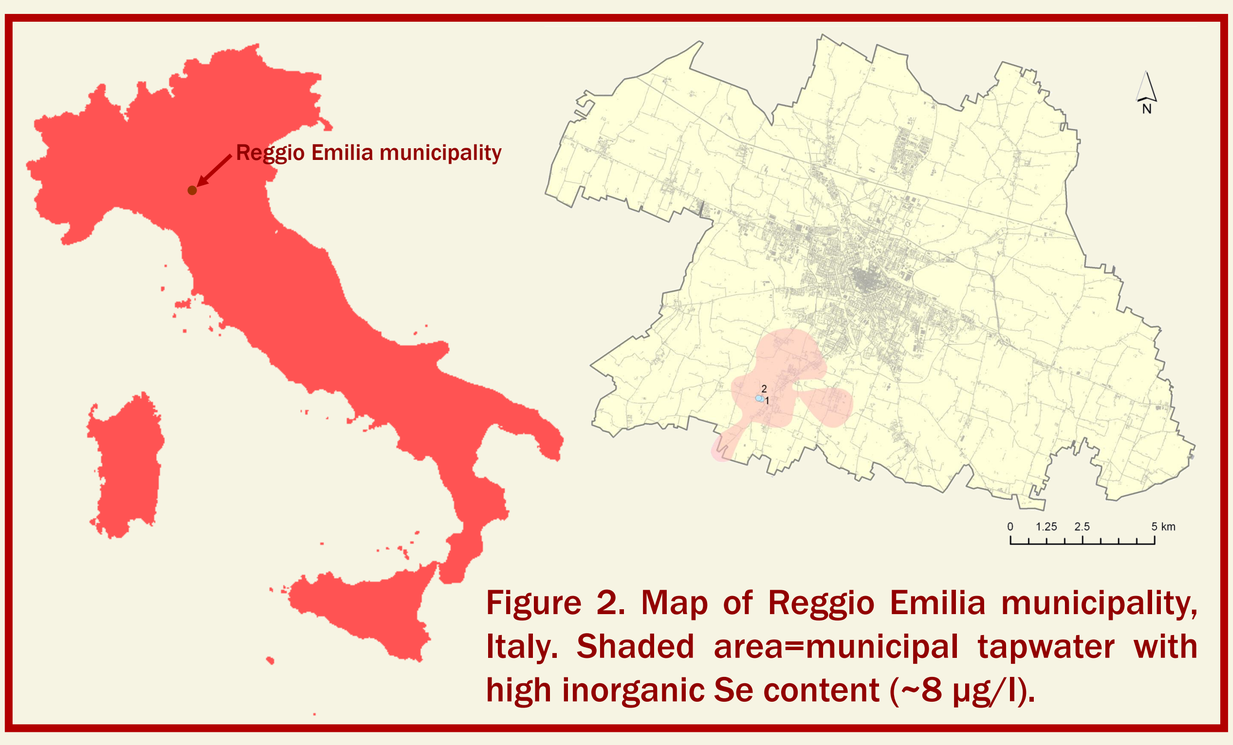

Figure 2. Map of Reggio Emilia municipality, Italy. Shaded area=municipal tapwater with high inorganic Se content (~8 µg/l).

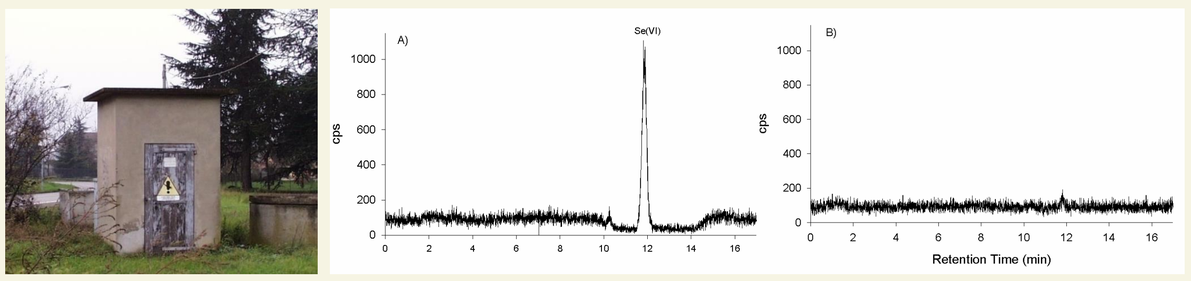

Figure 3. Chromatograms showing the results of Se speciation analysis for water samples distributed in the exposed and unexposed areas in Reggio Emilia municipality.

Results

In the overall period of follow-up, we noted little evidence of any change in mortality from cancer and from cardiovascular disease. For site-specific cancers, we noted an increased mortality from cancer of the buccal cavity and pharynx, melanoma, cancers of the urinary organs and lymphoid malignancies (mainly due to multiple myeloma), though these increases were statistically imprecise due to the limited number of cases. A limited evidence of a decreased mortality from breast cancer in females and of prostate cancer also emerged. Mortality from nervous disease was increased in this exposed cohort, due to excess rates for Parkinson disease and amyotrophic lateral sclerosis. Gender-specific analysis highlighted several slight or marked differences, though this might be due to the low number of cases in stratified analyses and not to real differential effects of the exposure under study in males and females.

The period-specific analysis showed a generally decreasing pattern of the excess mortality from most of the above-mentioned causes, suggesting a vanishing effect of the selenium exposure over time. These findings mirror the observations from randomized trials carried out in the US and in France, administering organic selenium in the intervention groups.

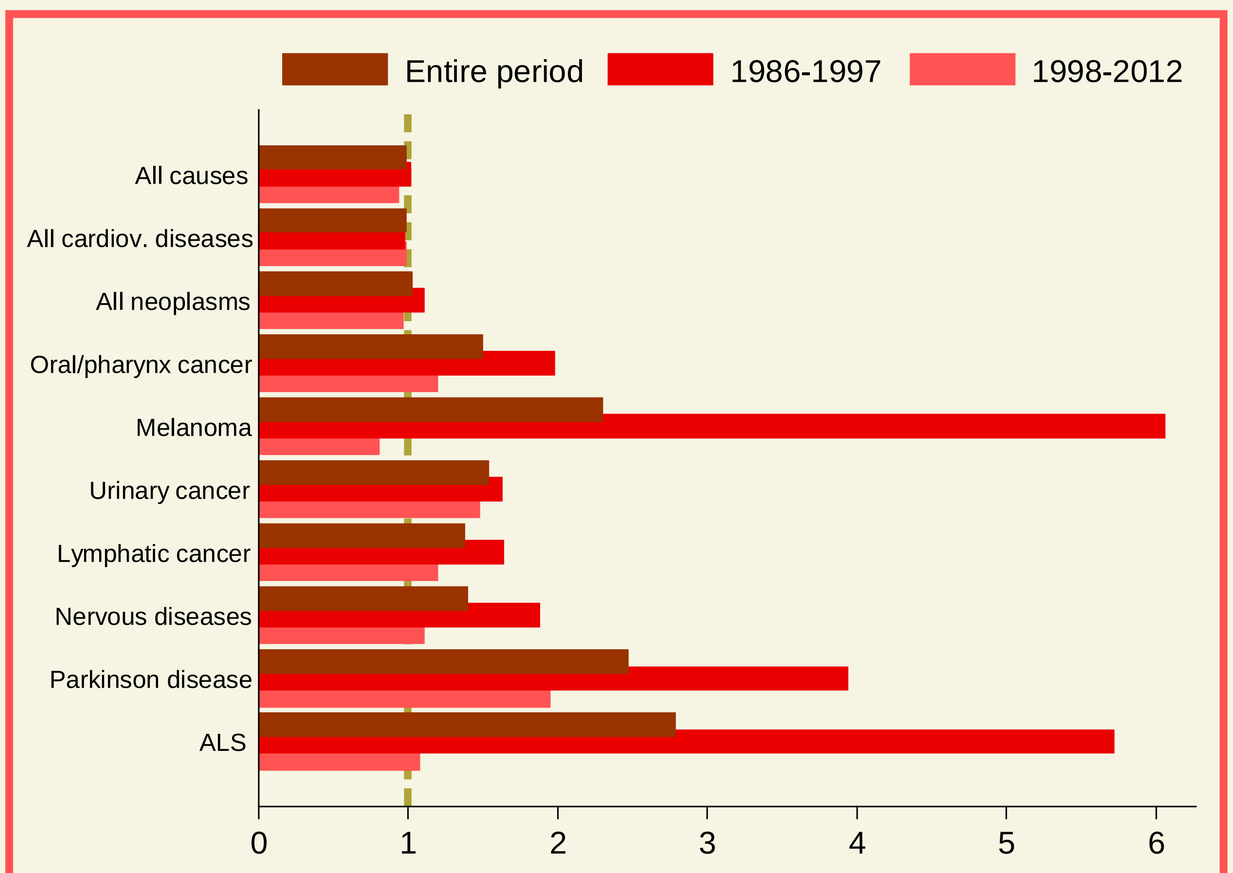

Figure 4. Relative risk of death from chronic diseases in the population exposed to inorganic selenium through drinking water. Overall period 1986-2012 and two time windows (1986-1997 and 1998-2012) were considered.

Conclusions

Overall, these results indicate that long-term exposure to inorganic selenium in drinking water close to the maximum allowed concentration may have detrimental effects on mortality, and that these effects tend to decrease over time after the end of the exposure.

Findings of the present study suggest that the issues of overexposure to inorganic selenium in the human and of adequacy of current standards for selenium in drinking water need to be further investigated and carefully reassessed.

RAMAZZINI DAYS 2015: Living in a Chemical World (IV° Edition)
22-25 October 2015 - Carpi, Italy

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