



## Pattern of cancer mortality in some Brazilian HBRAs

Lene H.S. Veiga<sup>a,\*</sup>, Sérgio Koifman<sup>b</sup>

<sup>a</sup>*Institute of Radioprotection and Dosimetry, Brazilian Nuclear Energy Commission, Brazil*

<sup>b</sup>*National School of Public Health, Oswaldo Cruz Foundation, Brazil*

**Abstract.** Among residents of Brazilian High Background radiation Areas, there is great concern about radiation-related health effects and there is also a common certitude that cancer incidence is higher in those areas than in other Brazilian areas with normal background radiation. This paper aims to present an overview of Brazilian High Background Radiation Areas and evaluate whether cancer mortality among residents from Poços de Caldas, Araxá, and Guarapari is higher than would be expected when applying mortality rate of their respective States. Results show that cancer mortality from the Brazilian HBRAs, Poços de Caldas, and Guarapari is higher than would be expected for their respective reference population. On the other hand, cancer mortality for the Araxá population is lower than would be expected. © 2004 Elsevier B.V. All rights reserved.

**Keywords:** Natural radiation; Cancer; Mortality; Poços de caldas; Araxá; Guarapari

### 1. Introduction

Some Brazilian locations have been globally recognized as High Background Radiation Areas (HBRAs); included among these are Poços de Caldas, Araxá, and Tapira, all located in Minas Gerais State and Guarapari, located in Espírito Santo State [1,2]. As a consequence of this recognition, residents of those areas have great concern about radiation-related health effects. There is a common sense among these populations that cancer incidence is higher than in other Brazilian areas with normal background radiation. Nevertheless, no previous cancer statistics have been shown to support this hypothesis and, until the present time, no health effect study had been conducted in Brazilian HBRAs. Most of the data concerning natural radiation exposure in those areas were obtained during

\* Corresponding author. Mailing address: Av. Salvador Allende, s/n, Recreio, Caixa Postal 37750, Rio de Janeiro, RJ, CEP 22642-970, Brazil. Tel.: +55 21 3411 8089; fax: +55 21 2442 2699.

E-mail address: lene@ird.gov.br (L.H.S. Veiga).

the late 1970s. Recently new assessments were performed at Poços de Caldas [3] and Guarapari [4]. Those results indicated that the great urbanization process in Guarapari changed the radiation exposure pattern; the external radiation exposure is at present lower than that in the past. The radiation level in Guarapari can be considered normal, except in the hot spots on the beaches and in the fishing village of Meaípe [4]. At Poços de Caldas, it was shown that only rural areas could be considered as high natural background radiation areas. The radiation dose in urban areas can be considered normal.

Therefore, this paper aims to assess whether there is an excess of cancer mortality among residents from Poços de Caldas, Araxá, and Guarapari in comparison with a reference population. The State of Minas Gerais was used as the standard population for Poços de Caldas and Araxá, and the Espírito Santo State for Guarapari.

## 2. Methodology

Mortality data on cancer and all other causes of death were examined for Poços de Caldas, Araxá, and Guarapari as well as for the States of Minas Gerais and Espírito Santo, which were used as reference areas. Mortality data from 1991 to 2000, obtained from the Brazilian National Mortality System, were evaluated for both sexes and for the following age intervals: <1, 1–4, 5–9, 10–14, 15–19, 20–29, 30–39, 40–49, 50–59, 60–69, 70–79, and 80 and over. Standardized mortality ratios (SMRs) for every city were estimated as the ratio of deaths observed to those expected. Expected numbers of death for the cities of Poços de Caldas and Araxá were obtained by multiplying the sex and age group stratum's population by different cancer sex-age-specific death rates for the Minas Gerais State. The expected numbers of deaths for Guarapari City were obtained by applying cancer sex-age-specific death rates for Espírito Santo State.

## 3. Results

Table 1 presents the observed and expected numbers of deaths for selected cancer and all causes of death for cities of Araxá and Poços de Caldas, respectively, using the specific general mortality for Minas Gerais State as the standard population. For the Araxá population, mortality for all causes of death was significantly higher than expected from the reference population (SMR=118, CI=115–121). Nevertheless, total cancer did not

Table 1  
Standardized mortality ratios for Araxá and Poços de Caldas City, both genders, 1991–2000

International classification of diseases		Cause of death	ARAXÁ		POÇOS DE CALDAS	
ICD-9	ICD-10		Obs	SMR (95% CI)	Obs	SMR (95% CI)
001–999	A00–Z99	All causes	5059	118 (115–121)	8355	115 (113–118)
140–239	C00–D48	All cancer sites	479	100 (60–156)	1122	141 (133–149)
150	C15	Esophagus	17	60 (35–97)	32	65 (44–92)
151	C16	Stomach	42	79 (56–106)	133	143 (120–170)
161	C32	Larynx	9	96 (44–183)	21	126 (78–193)
162	C33–C34	Lung	37	79 (56–109)	113	138 (114–166)
174	C50	Female Breast	23	77 (49–116)	78	166(131–207)
185	C61	Prostate	35	132 (92–184)	57	120(91–156)
204–208	C91–C95	All leukemias	19	100 (60–156)	49	154 (114–204)

Table 2  
Standardized mortality ratios for Guarapari City, both genders, 1991–2000

International classification of diseases		Cause of death	Obs	SMR 95% CI
ICD-9	ICD-10			
001–999	A00–Z99	All causes	3942	95 (92–98)
140–239	C00–D48	All cancer sites	468	109 (99–119)
150	C15	Esophagus	42	160 (115–216)
151	C16	Stomach	90	169 (136–208)
161	C32	Larynx	9	105 (48–199)
162	C33–C34	Lung	77	156 (123–195)
174	C50	Female breast	28	121 (80–175)
185	C61	Prostrate	48	197 (145–261)
204–208	C91–C95	All leukemias	19	99 (59–155)

exceed the expectation and no statistically significant excess was observed for any selected cancer sites.

For Poços de Caldas, mortality for all causes and all cancers were significantly higher than expected. Among single cancer sites, stomach, lung, breast, and leukemia showed statistically significant excess. Larynx and prostate showed non-significant excesses ranging from 20% to 26%, whereas esophagus cancer was below the expectation. Among leukemia subtypes, lymphocytic and myelocytic leukemia presented a nonstatistically significant excess (SMR=120, CI=60–215 and SMR=123, CI=74–193, respectively), whereas for cellular type not specified, statistically significant excess was observed (SMR=242, CI=146–378).

Table 2 presents the standardized mortality ratio for the Guarapari population, using the specific general mortality for Espírito Santo State. Mortality for all causes was significantly lower than expected (SMR=95, CI=92–98), whereas a nonsignificant excess of 9% was observed for all cancer mortality. Among single cancer sites, high statistically significant SMRs were observed for esophagus, stomach, lung, and prostate cancer. Mortality from leukemia was close to the rate expected, whereas larynx and breast cancer were slightly higher than expected, although not statistically significant.

#### 4. Discussion

Studies of geographical variation need to be interpreted with caution because many factors other than environmental exposure can contribute to such variation in the recorded frequency of disease or death. Mortality data can be affected by varying qualities of cause of death certification and differences in survival among regions. The imprecision in the information produces a dilution effect and biases the results. Genetic and ethnic factors may confound geographical variations, and migration patterns may also affect geographical comparisons if there are substantial inward or outward movements.

Despite the higher cancer mortality observed for some cancer sites in the Poços de Caldas population, the estimated doses from natural radiation at Poços de Caldas indicated that only the rural population would be highly exposed. For the Guarapari population, the higher cancer mortality cannot be related to the radiation exposure, based on the fact that radiation levels in Guarapari city can be considered normal, with high spots only at the beaches, and levels are not significant concerning chronic public exposure.

The observed excess cancer mortality in Poços de Caldas and Guarapari HBRA must be seen as the result of a very preliminary study, and further analysis should include other important variables, such as socioeconomic status, smoking, and dietary habits, as well as other aspects of environmental exposure such as pesticide use in agricultural activities (mainly for Poços de Caldas). Quality of cause of death certification in those regions must be also assessed.

## 5. Conclusion

This report represents the first time that cancer mortality has been assessed for Brazilian HBRA. It was observed that cancer mortality for Poços de Caldas and Guarapari is higher than would be expected for their respective reference populations, Minas Gerais State and Espírito Santo State, respectively. On the other hand, cancer mortality for the Araxá population is lower than would be expected.

Nevertheless, natural radiation levels at those regions cannot be associated with this excess cancer mortality. Other aspects of environmental exposure must be investigated in a more consistent study.

## References

- [1] T.L. Cullen, Review of the Brazilian investigations in areas of high natural radioactivity. Part I: Radiometric and dosimetric studies, in: T.L. Cullen, E. Penna Franca (Eds.), Proc. of the International Symposium on High Natural Radioactivity, Poços de Caldas, Brazil, 20 Junho 1975, Academia Brasileira de Ciências, RJ, 1975, p. 49.
- [2] E. Penna Franca, et al., Status of investigations in the Brazilian areas of high natural radioactivity, Health Physics 11 (1965) 671–699.
- [3] L.H.S. Veiga, et al., Preliminary indoor radon risk assessment at the Poços de Caldas Plateau, MG-Brazil, Journal of Environmental Radioactivity 70 (2004) 161–176.
- [4] I. Sachet, Caracterização da radiação gama ambiental em áreas urbanas utilizando uma unidade móvel de rastreamento. PhD thesis. Instituto de Biociências Nucleares, Universidade Estadual do Rio de Janeiro (in Portuguese).