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BRAZILIAN PEOPLE STILL UNDER INCREASED RISK OF CANCER DEVELOPMENT DUE TO ORGANOCHLORINE PESTICIDE INHALATION EXPOSURE

Yago Guida, João P.M. Torres, Rodrigo O. Meire

Introduction

Organochlorine pesticides (OCPs) in Brazil

- ✓ OCP applications started in the 1940's.
- ✓ Wide application to fight insect-borne diseases.
- ✓ Governmental production of DDT & lindane (1950).

Restrictions

- 1971: DDT & BHC (lindane) for domestic animals and OCPs for pasture.
- 1985: OCPs for agricultural activities.
- 1998: OCPs for sanitation campaigns.
- 2001: Stockholm Convention on Persistent Organic Pollutants.

Introduction

Remarkable cases of environmental contamination by OCPs

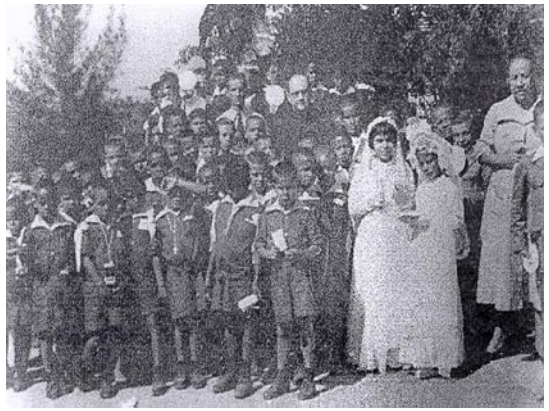
- **Cidade dos Meninos, RJ**

1950's – the government started producing DDT and lindane.

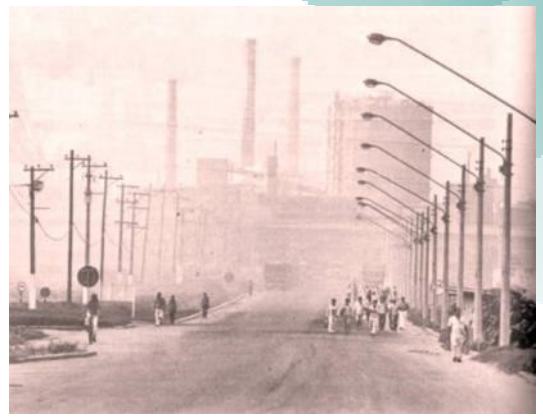
1960's – the factory was closed and ~300 tonnes (2.5 km^2) were left behind.

1990's – studies started to report high levels of OCPs in human blood.

2000's – several studies reported toxicological outcomes in residents and former employees of the pesticide factory.



Introduction



Remarkable cases of environmental contamination by OCPs

- **Rodhia Case, SP**

1970's – OCP and other chemical residues were dumped in the surroundings of a chemical company.

The open dumping resulted in ~300 tonnes of contaminated soil and impacted rivers and underground waters.

Several studies have reported health issues related to OCP exposure.

For both cases, the authorities claimed no possible remediation!

Study area and sampling

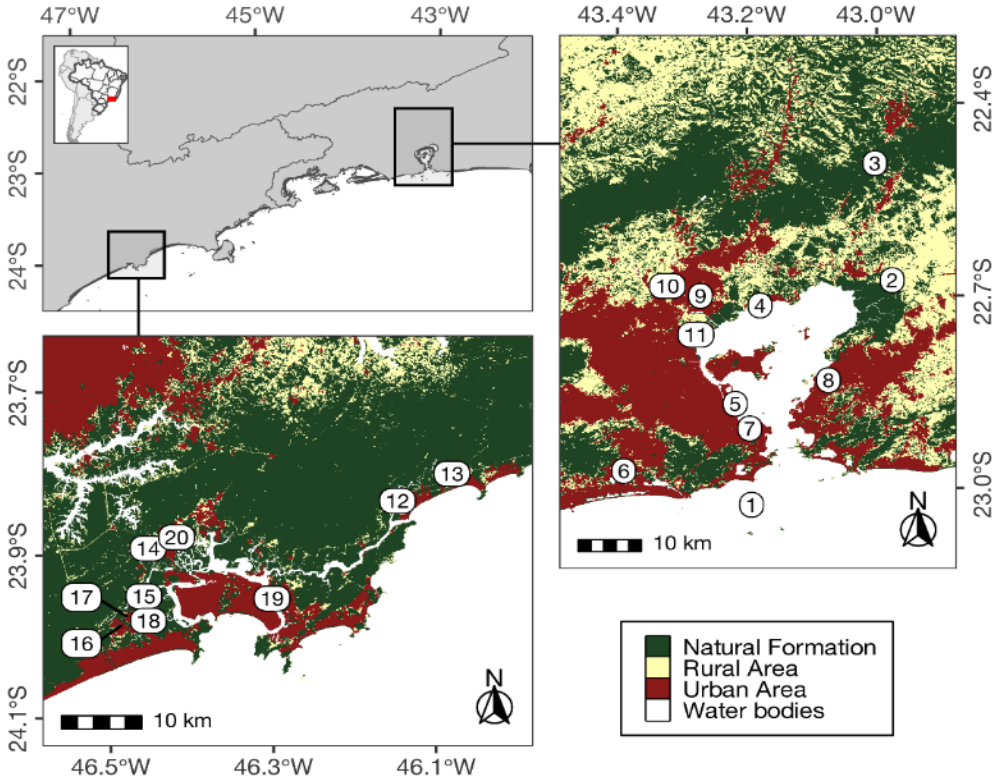
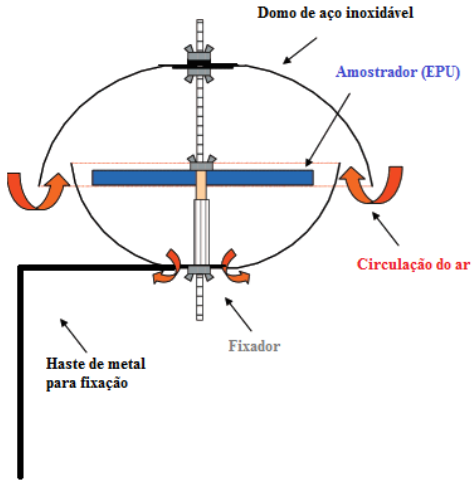


Figure 1: Sampling sites around Santos and São Vicente estuary (SP; left) and Baía de Guanabara (RJ; right), southeast Brazil



20 sampling points covering background, urban, industrial, and chemical dumping sites.

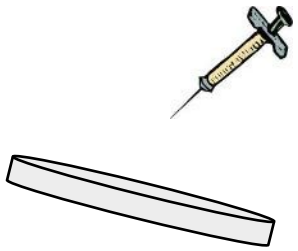
Two sampling campaigns (winter & summer; 2015–2016). ~90 days each.

PUF-PAS with depuration standard spikes.

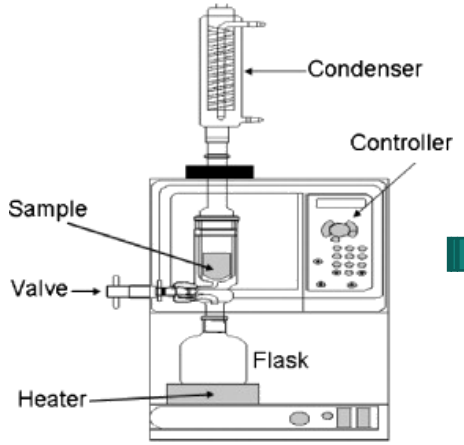
Method

Automatic Soxhlet with organic solvent

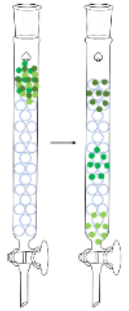
d_6-*α*-HCH & d_8-*p,p'*-DDT

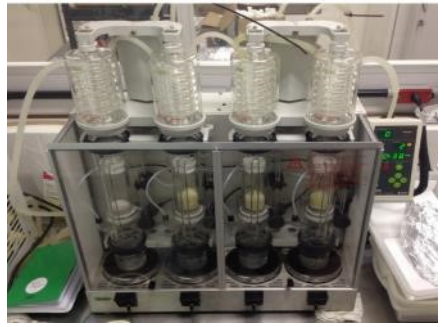


PUF disk

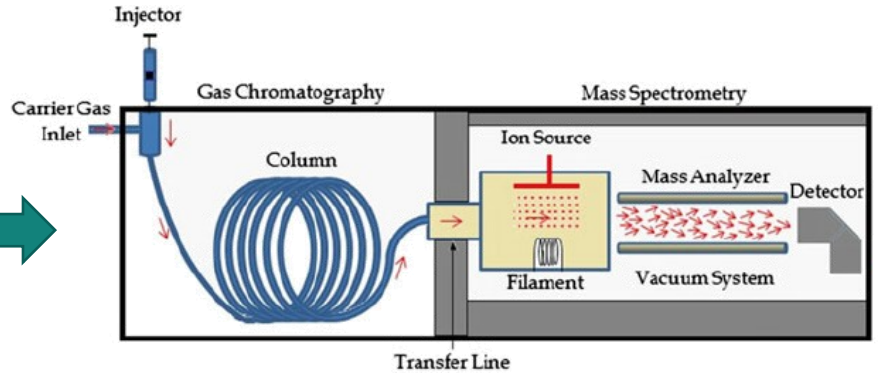


Activated silica (n-hexane)





TCMX



GC/ECNI-MS
Sim mode

Output and data analysis

Risk assessment

Inhalation cancer risks based on USEPA guides

$$\mathrm{CR} = \mathrm{C_p} \times \mathrm{IF} \times \mathrm{ADAF} \times \mathrm{CSF};\ \mathrm{IF} = \frac{IR \times ET \times EF \times ED}{1440 \left(\frac{min}{day}\right) \times AT \times BW}$$

CR = cancer risk

C_p = OCP concentration

IF = intake factor

ADAF = age-dependent adjustment factor

CSF = cancer slope factor

IR = inhalation rate

ET = exposure time

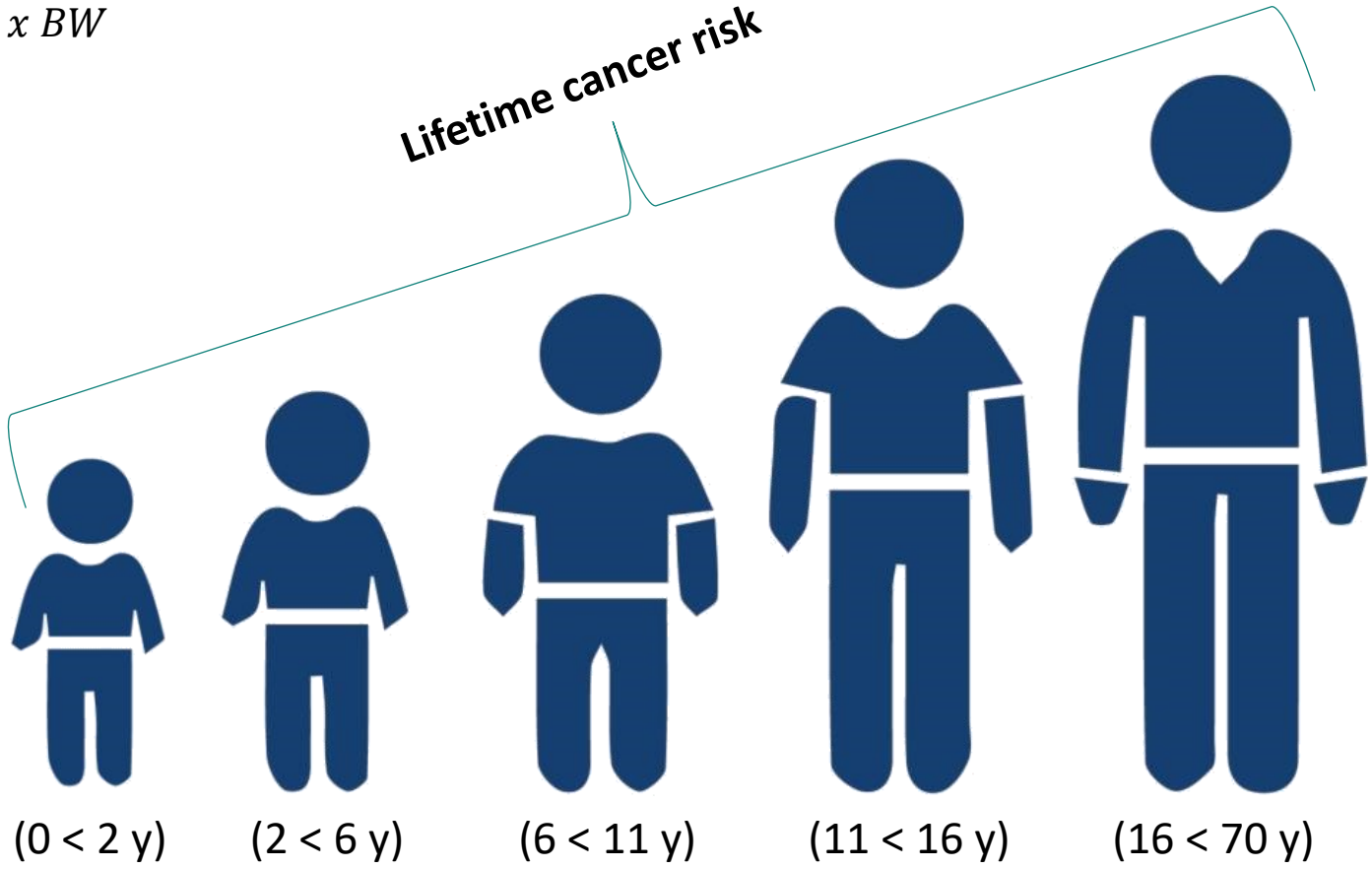
EF = exposure frequency

ED = exposure duration

BW = body weight

AT = averaging time

1.0×10^5 Two-dimensional Monte-Carlo simulations



Results

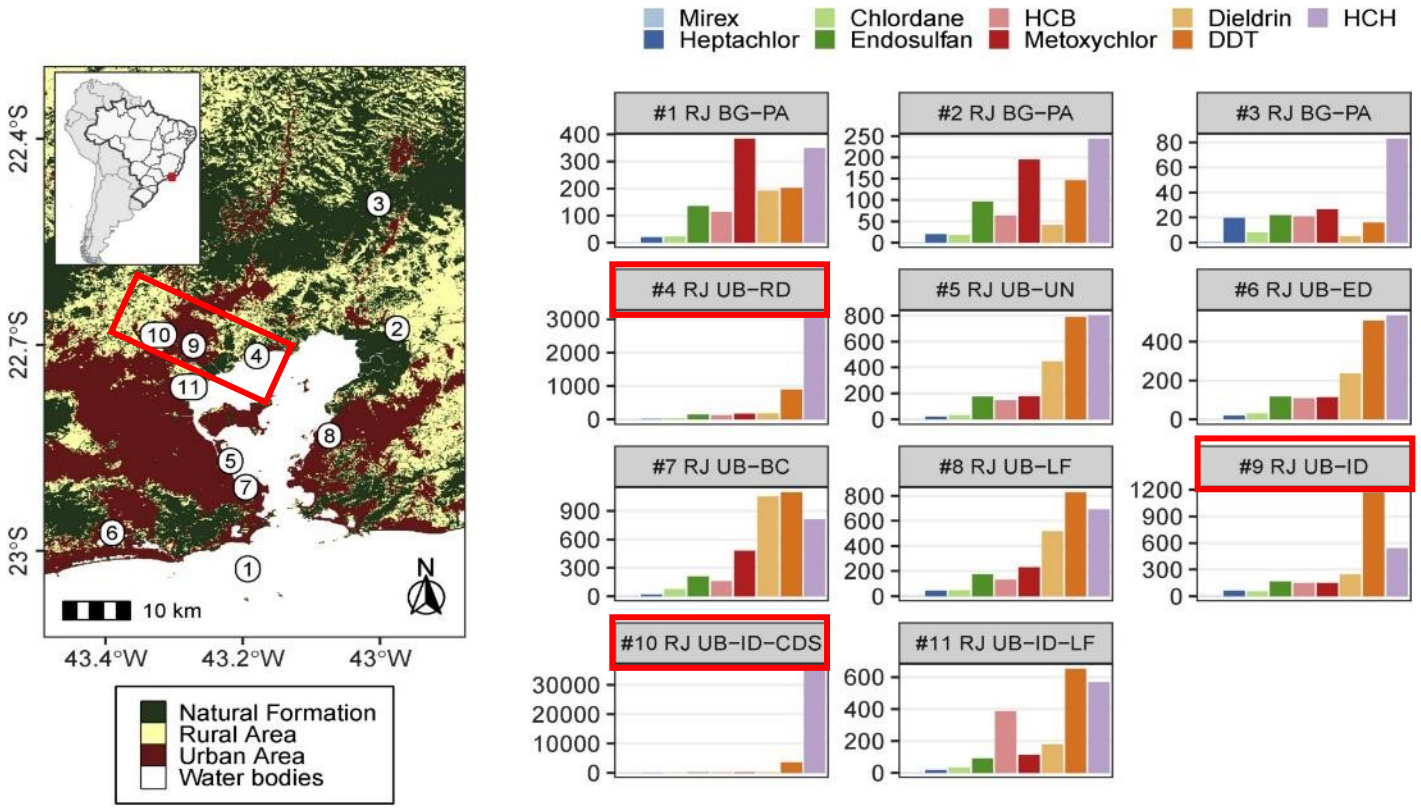


Fig. 1. Sampling sites identified from #1 to #11 around Guanabara Bay (RJ); major land occupation and activity impact (BG = background; UB = urban; ID = industrial; CDS = chemical dumping site); and mean concentrations of OCPs (pg m^{-3}) measured in outdoorair samples during winter and summer at each sampling site. Grouped OCPs: *cis*- and *trans*-(chlordane); *α*- and *β*-(endosulfan); *o,p'* and *p,p'*-DDD; *o,p'* and *p,p'*-DDE; *o,p'*-DDT (DDT); *α*-, *β*-, *δ*- and *γ*-HCH (HCH). HCB = hexachlorocyclobenzene.

OCPs are presented as the sum of their congeners (winter and summer means).

A similar contamination pattern was observed.

HCH and DDT showed outstanding concentrations in air for most sites.

A few hotspots were identified and HCH showed very high concentrations at Cidade dos Meninos.

Methoxychlor and dieldrin showed surprisingly high concentrations at some sites

Results

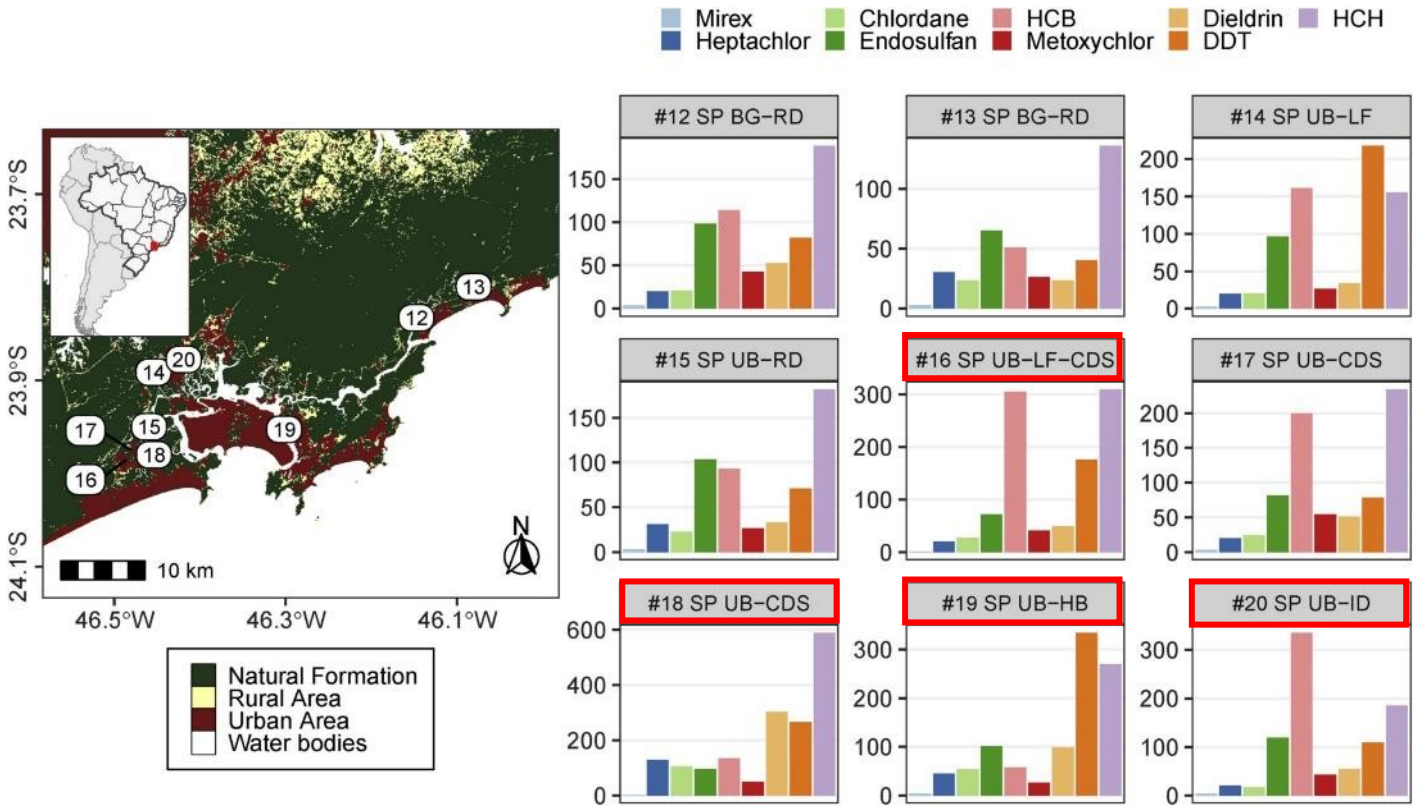


Fig. 2. Sampling sites identified from #12 to #20 around Santos and São Vicente estuary (SP); major land occupation and activity impact (BG = background; UB = urban; ID = industrial; CDS = chemical dumping site); and mean concentrations of OCPs (pg m-3) measured in outdoor air samples during winter and summer at each sampling site. Grouped OCPs: cis- and trans-(chlordane); α- and β-(endosulfan); o,p' and p,p'-DDD; o,p' and p,p'-DDE; o,p'-DDT (DDT); α-, β-, δ- and γ-HCH (HCH). HCB = hexachlorocyclobenzene.

In SP concentrations were relatively lower than in RJ.

HCB was more relevant to the total OCPs than in RJ.

Chlordane and heptachlor were also relatively higher.

Hotspots were associated to former dumping sites.

Most OCPs showed a positive correlation with the population within a 25 km radius

Results

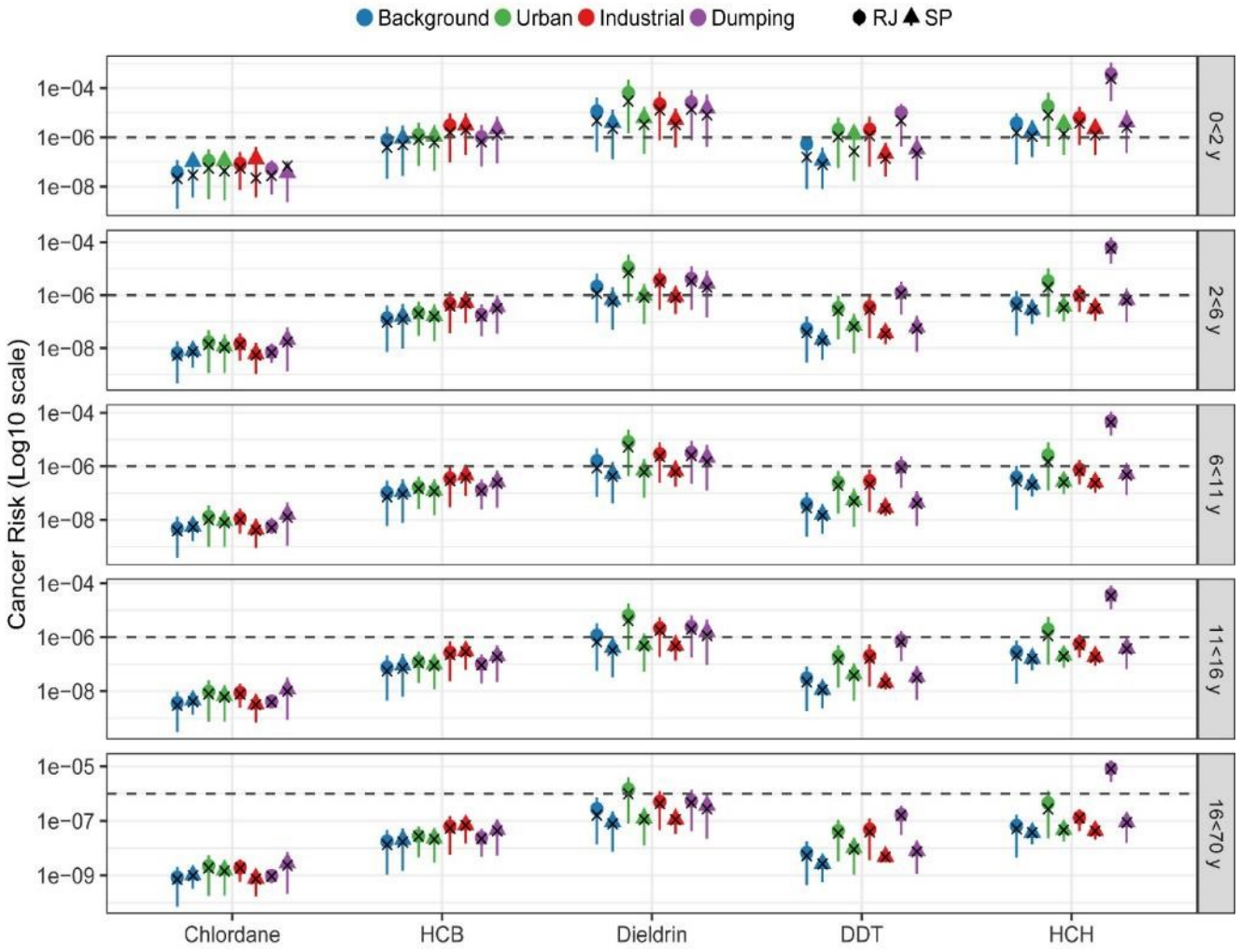


Fig. 5. Inhalation cancer risk (CR) estimations for five age groups of people living at background (blue), urban (green), industrial (red) and chemical dumping (purple) areas of Rio de Janeiro (circle) and São Paulo (triangle) states. X represents the deterministic CR estimations while colorful dots and vertical bars represent mean values and 95th confidence interval from Monte-Carlo simulations, respectively. EPA safety limit of 1×10^{-6} was represented as dashed lines.

Conclusions

- ✓ Former pesticide production sites and dumping sites are still hotspots of OCP contamination in Brazil.
- ✓ Despite the hotspots OCPs were measured in all sampling sites.
- ✓ Inhalation cancer risk assessments showed an increased risk of developing hepatic tumors in up to 100% of the probabilistic analysis for HCH at Cidade dos Meninos.
- ✓ The cancer risk is higher for younger individuals.
- ✓ This study demonstrates that OCPs are still a problem, long after their phase-out; and that more studies considering other exposure pathways and human biomonitoring is needed at those regions.

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Atmospheric Occurrence of Organochlorine Pesticides and Inhalation Cancer Risk in Urban Areas at Southeast Brazil☆

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